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**Final Report**

# A Biological, Geological, Oceanographic Study of the Lancaster/Eclipse Sound Region for the Purpose of Potential Marine Park Boundary Delineation

by

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Parks Canada Parcs Canada

July 1986

Our file Notre reference

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Note to the Reader

Eclipse and eastern Lancaster sounds and their connecting waterways were identified some years ago as the best area in the eastern Canadian Arctic for a national marine park.

In 1985, Environment Canada, Parks contracted the authors of this report to undertake a detailed study of natural and cultural themes, constraints and visitor opportunities in the entire eastern Lancaster Sound marine region. The authors were also asked to describe and compare marine park boundary options based primarily on achieving a high degree of thematic representation, and to recommend an optimum park boundary.

The boundary options and recommendations which are presented here enclose a large area whose protection would maximize thematic representation of the Lancaster Sound marine environment while allowing for the continuation of other resource uses such as shipping, exploration for oil outside park boundaries, and traditional Inuit hunting and fishing. They do not represent Environment Canada's final proposal for a possible marine park in the region, but are intended as a starting point for further planning work and discussion. A preliminary park proposal is now being prepared by Environment Canada, and discussions will take place thereafter within the forums of northern land use planning, negotiation of the Tungavik Federation of Nunavut lands claim, community consultations, and meetings between the federal and territorial governments and with concerned federal departments and agencies.

## SUMMARY

This report provides a summary of natural marine resources that occur in the Lancaster/Eclipse Sound area and recommends boundaries for a marine park in that area. Outstanding physical resources of the region include: high coastal relief, tide-water glaciers and ice sheets, the Lancaster Sound Ice Arch, polynya and offshore leads. Outstanding biological resources include: major concentrations of migratory and nesting marine birds and very high concentrations of marine mammals. Important cultural features include: extensive areas of traditional harvest use and high concentrations of archaeological and historic (compared to other areas of the Arctic). All of these features are well represented within the recommended park boundaries.

Recommended boundaries are illustrated in Figure A. The eastern boundary corresponds closely to the territorial sea boundary except (a) in central Lancaster Sound where it lies inside the territorial boundary to minimize potential use conflicts with offshore exploration and (b) to the east of Pond Inlet where the recommended park boundary extends seaward the territorial sea boundary to incorporate natural themes associated with a recurring polynya in the area. The western boundary has been located to the west of that originally proposed (Dobbin, 1981a) to improve: (a) representation of the Lancaster Sound Ice Arch, a significant biophysical feature of the area; (b) seabird colony representation; and (c) marine mammal habitat representation. Improvement in representation of natural themes could be further improved by placing the boundary between Somerset and southwestern Devon Island; this alternative is discussed within our report but was not recommended because it departed significantly from our original terms of reference.

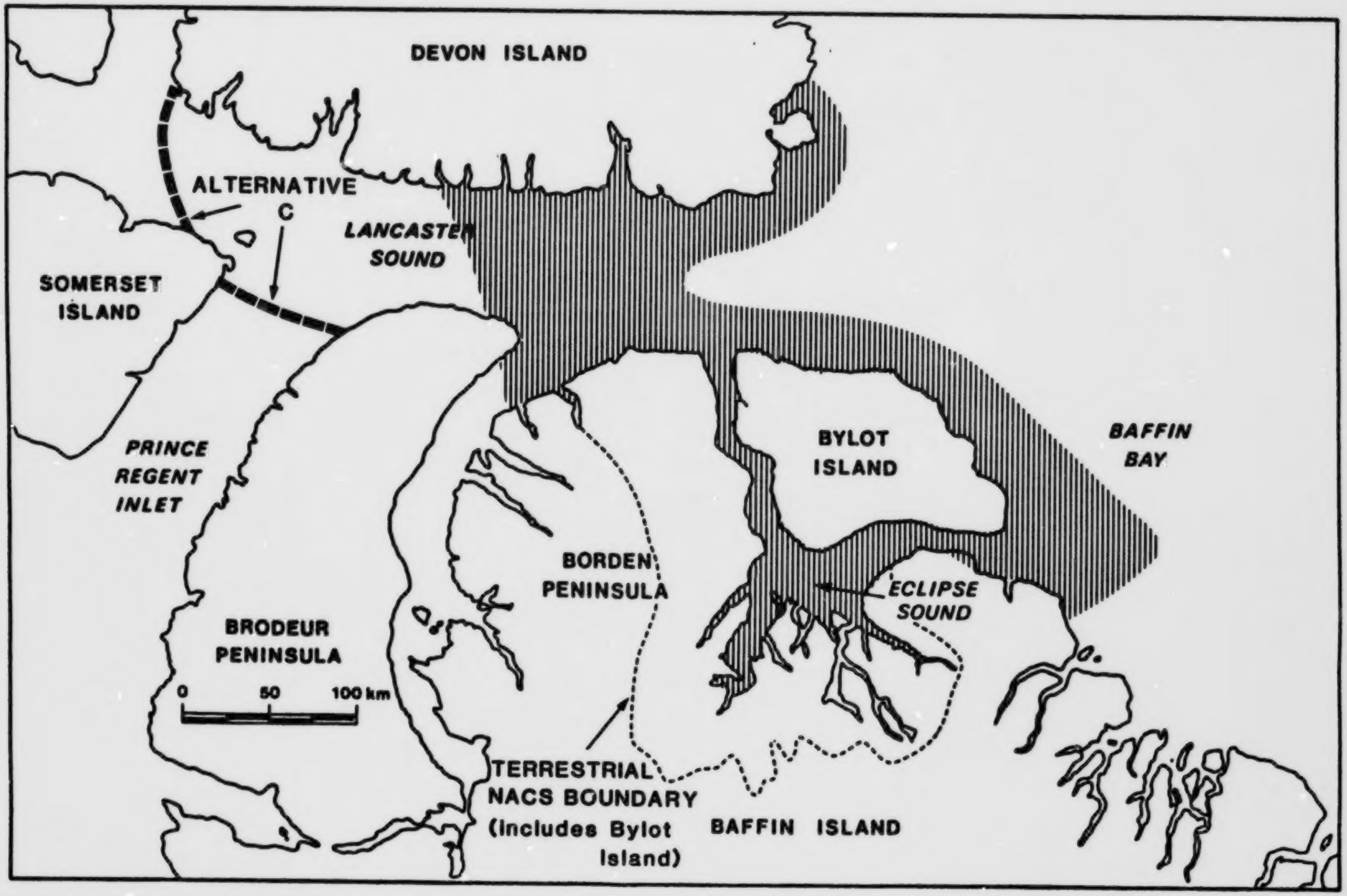
DEVON ISLAND
ALTERNATIVE C
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BRODEUR PENINSULA
0
50
100 km
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
ECLIPSE SOUND
TERRESTRIAL NACS BOUNDARY (Includes Bylot Island)
BAFFIN ISLAND

**Figure A.** Preferred boundaries of Lancaster/Eclipse Sound marine park. Note good overlap with terrestrial NACS boundaries. Selection of Alternative "C" would substantially improve representation of natural themes, but require significant increase of park area.

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# 1.0 INTRODUCTION

This report was prepared for Parks Canada to define the boundaries for a potential national marine park within the Lancaster Sound Marine Region. The primary area of interest is centered on Lancaster Sound, Eclipse Sound and other waters surrounding Bylot Island and northern Baffin Island.

## 1.1 STATEMENT OF PROBLEM

Three independent studies, Dunbar and Moore (1978), James Dobbin Associate (1981a), and Woodward-Clyde Consultants (1981) have designated various parts of the eastern Lancaster Sound/Eclipse Sound region as a marine Natural Area of Canadian Significance (NACS). However, each study made this recommendation on the basis of a relatively superficial review of natural themes over a wide expanse of Canadian arctic waters.

Dobbin's (1981a) definition of a NACS encompassing all of Eclipse Sound and extending across the entire width of Lancaster Sound (Figure 1.1) was published in the Lancaster Sound Regional Study report (DIAND, 1982) as representing Parks Canada's definitive marine area of interest in the region. However, concurrent and subsequent discussions within Parks Canada and with other interested parties, including residents of Pond Inlet, have given stronger consideration to a park outline which incorporates all of Eclipse Sound but extends into Lancaster Sound no more than 12 miles from the coasts of Bylot Island and the Borden Peninsula. This divergence of park concepts has been due in large degree to the lack of a comprehensive review of natural theme information upon which to base park boundary decisions.

Meanwhile, two other land-use studies have quickly been gathering momentum: (1) northern land use planning (NLUP) in the Lancaster Sound region, under the joint sponsorship of the Government of the Northwest Territories and

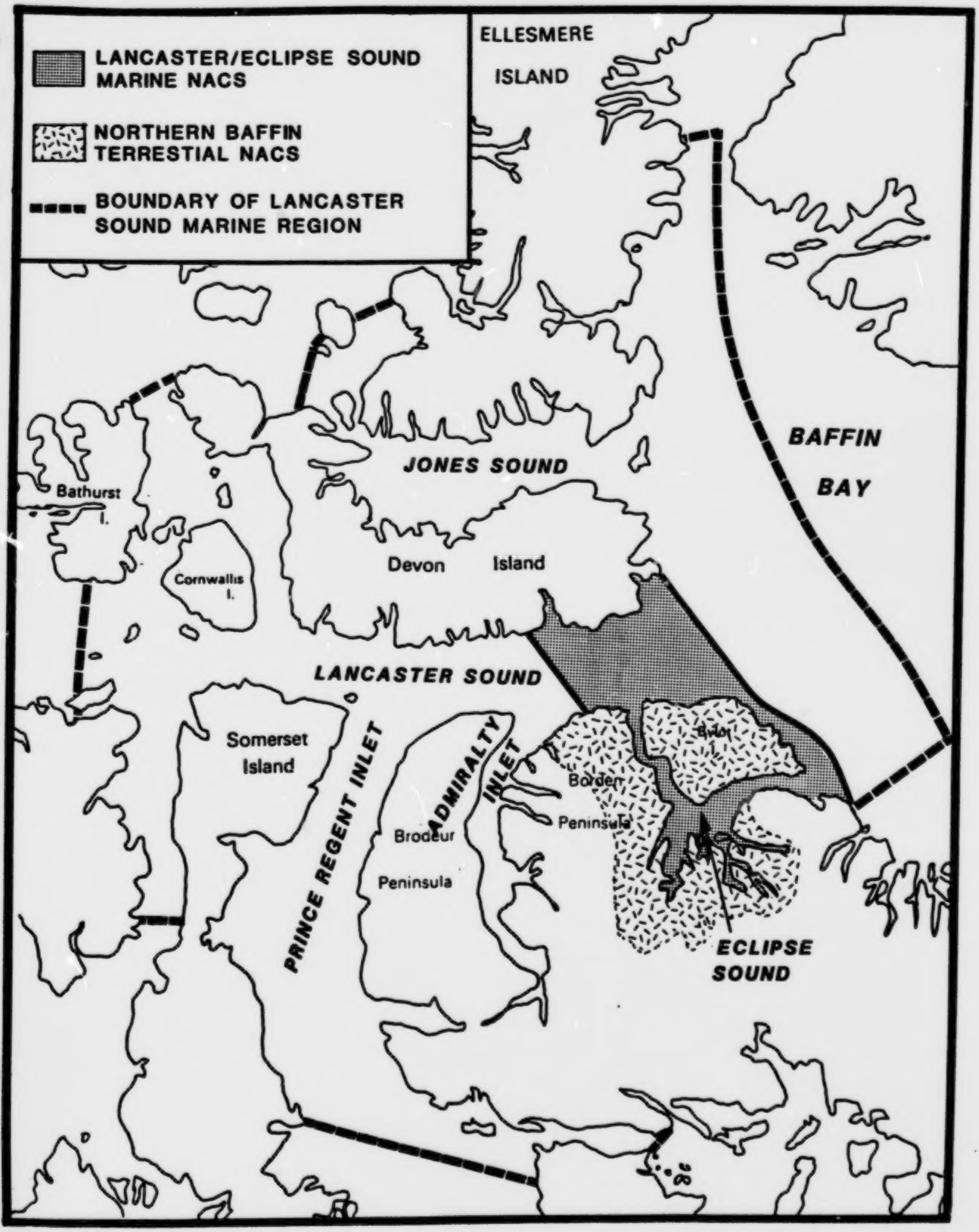

LANCASTER/ECLIPSE SOUND MARINE NACS
NORTHERN BAFFIN TERRESTIAL NACS
BOUNDARY OF LANCASTER SOUND MARINE REGION
ELLESMERE ISLAND
BAFFIN BAY
JONES SOUND
Bathurst I.
Cornwallis I.
Devon Island
LANCASTER SOUND
Somerset Island
PRINCE REGENT INLET
ADMIRALTY INLET
Brodeur Peninsula
Borden Peninsula
Bylot
ECLIPSE SOUND

**Figure 1.1** Lancaster Sound marine region (1983), bounded by heavy dashed line. Lancaster Sound/Eclipse Sound marine NACS. (Dobbin, 1981a), shaded area. Terrestrial NACS, cross-hatched area.

the federal Department of Indian Affairs and Northern Development, and (2) the Inuit land selection process leading to formal negotiation of a comprehensive eastern Arctic claims settlement between government and the Tungavuk Federation of Nunavut (TFN).

All of these factors have made it important that Parks Canada now complete precise definition of a proposed marine park area which would best represent the biotic, abiotic and cultural themes of the Lancaster Sound Marine Region. It is desirable that the maximum representation of natural themes be incorporated within an area that provides for conservation, opportunities for visitor use and a minimum of conflict with other potential resource uses. In addition, consideration of the proposed terrestrial North Baffin national park adjacent to Eclipse Sound, and its potential impact and benefits on the marine NACS, is of importance.

## 1.2 OBJECTIVES

The goals of this project were to assemble and review available biological physical, oceanographic, and cultural data for the Lancaster Sound/Eclipse Sound NACS in the Lancaster Sound Marine Region (Figure 1.1), and to define marine park boundary options which should minimize potential conflict with other resource use requirements while maximizing the representation of natural themes in the region.

To this end, the study included the following:

(1) a description of the biological, geological, oceanographic and cultural features of Lancaster Sound/Eclipse Sound waters and adjacent coasts;

(2) an assessment of the current naturalness of the Lancaster Sound/ Eclipse Sound environment and possible future constraints arising from other potential resource uses;

(3) an assessment of available opportunities for visitor use;

(4) the definition of boundary options for an area which best satisfies the requirements of a national marine park within the Lancaster Sound/Eclipse Sound NACS; and

(5) an assessment of this sub-area with regards to the Lancaster Sound/Eclipse Sound NACS and the entire Lancaster Sound marine region.

## 1.3 STUDY AREA

The area of interest is included in Figure 1.1 and indicates the relationship of the Lancaster Sound/Eclipse Sound NACS to (a) the Lancaster Sound Marine Region and (b) the terrestial NACS on northern Baffin Island and Bylot Island.

Other significant geographic features in the area are: (1) the eastern terminus of the Northwest Passage, (2) the international boundary between Greenland and Canada and the (3) Bylot Island Migratory Bird Sanctuary which incorporates the terrestrial and nearshore areas of Bylot Island.

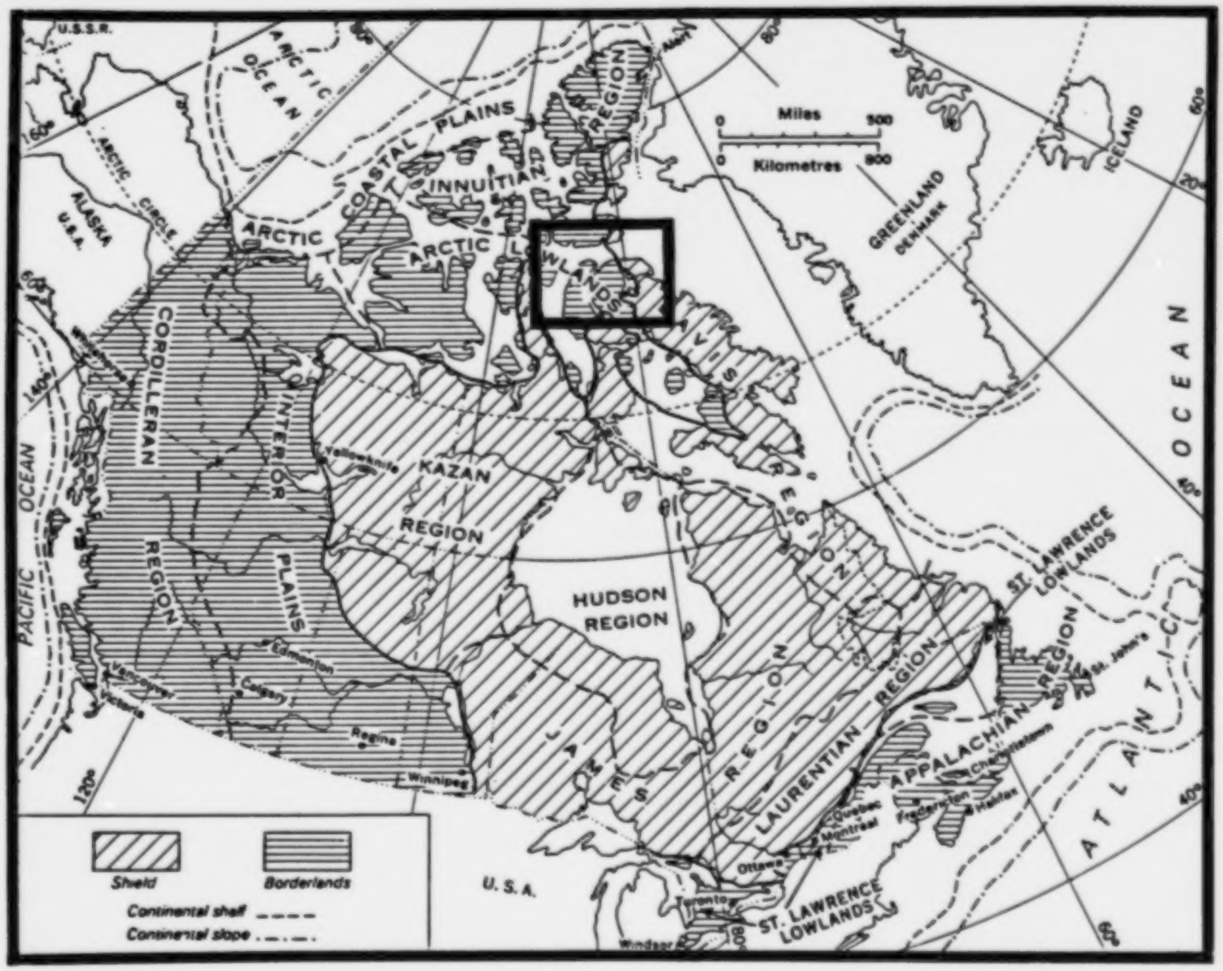
# 2.0 DESCRIPTION OF THE REGION

The Lancaster Sound/Eclipse Sound region is described in detail in this chapter, with respect to coastal and submarine geology, oceanographic features, climate, marine habitats, biological community, marine history and prehistory.

## 2.1 COASTAL AND SUBMARINE GEOLOGY

The eastern Canadian Arctic can be divided into two distinct physiographic and geological units. These are a) the Shield, a core of Pre-Cambrian igneous and metamorphic rocks and b) the Borderlands, predominantly flat-lying Paleozoic and late Proterozoic sedimentary rocks (Bostock, 1976); see Figure 2.1. Both the Shield and the Borderlands can be sub-divided into regions, divisions and subdivisions. Within the Lancaster Sound/ Eclipse Sound study area the shield rocks lie within the Davis Region and are further divided into the Davis Highlands and Baffin Upland (Figure 2.2). The Borderlands within the study area are contained within the Lancaster Plateau, a division of the Arctic Lowlands Region.

The area is characterized by rough mountainous terrain dissected by numerous valleys and drainage channels (Figure 2.3). Valley glaciers and ice sheet tongues are active along the coast, and relict and modern outwash channels have carried abundant sediments to the shore zone. Coarse sediment beaches are common along most of the shorelines. The submarine geology and structure is similar to that of the coastal geology. Characteristically the marine areas are the result of structural lows or drowned glacial valleys.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ARCTIC OCEAN
COASTAL PLAINS
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ICELAND
ALASKA U.S.A.
ARCTIC CIRCLE
ARCTIC LOWLANDS
CORDILLERAN REGION
INTERIOR PLAINS
Whitehorse
Yellowknife
KAZAN REGION
DAVIS REGION
HUDSON REGION
JAMES REGION
LAURENTIAN REGION
APPALACHIAN REGION
ST. LAWRENCE LOWLANDS
ST. LAWRENCE LOWLANDS
St. John's
Charlottetown
Fredericton
Halifax
Quebec
Montreal
Ottawa
Toronto
Windsor
Winnipeg
Regina
Calgary
Edmonton
Vancouver
Victoria
PACIFIC OCEAN
ATLANTIC OCEAN
U.S.A.
Shield
Borderlands
Continental shelf
Continental slope
160°
140°
120°
80°
60°
50°
40°
20°

Figure 2.1 Physiographic regions of Canada, (after Bostock, 1976). Study area enclosed in box.

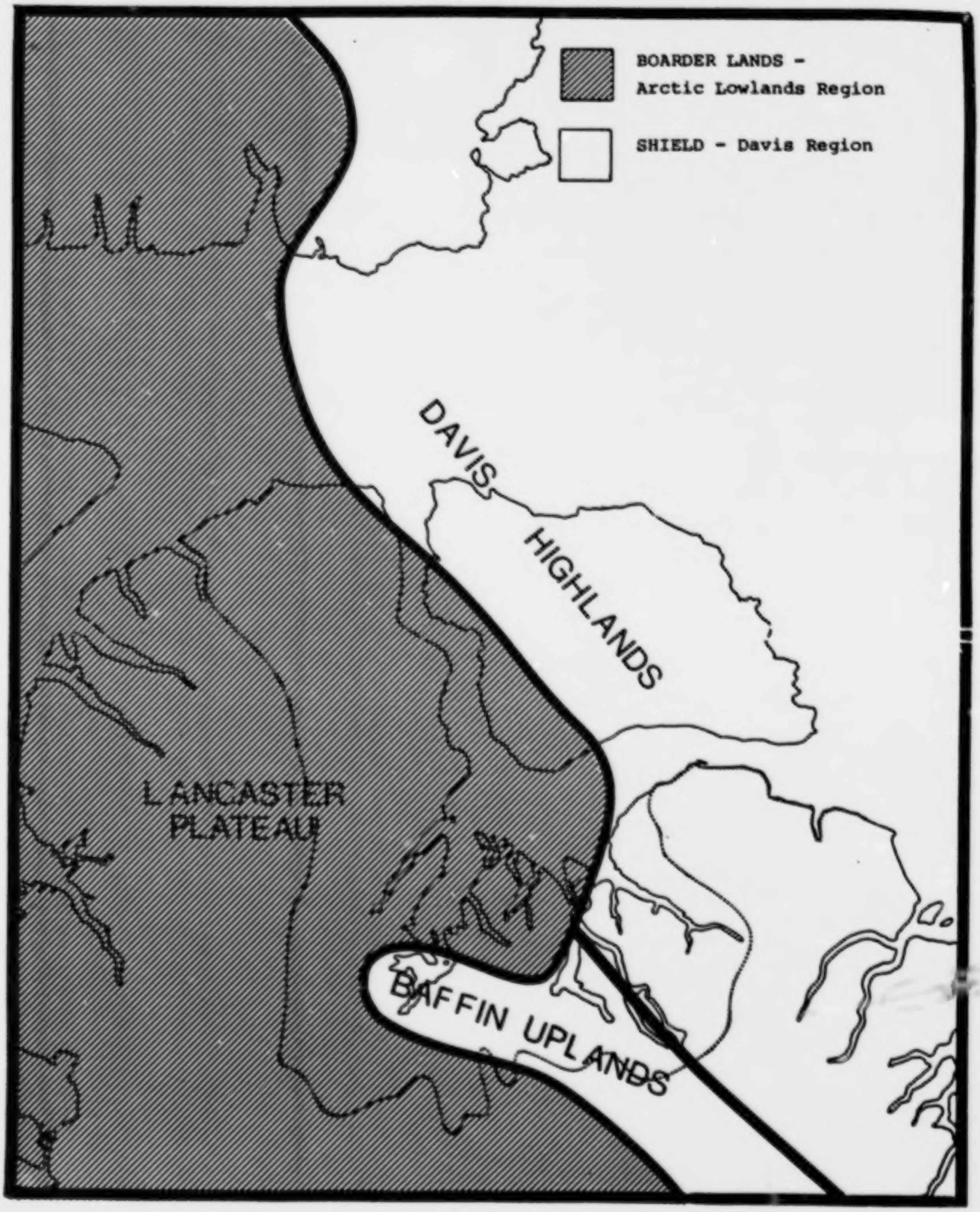

BOARDER LANDS - Arctic Lowlands Region
SHIELD - Davis Region
DAVIS HIGHLANDS
LANCASTER PLATEAU
BAFFIN UPLANDS

Figure 2.2 Physiographic regions and divisions of the Bylot Island/Eclipse Sound region and divisions (after Bostock, 1976).

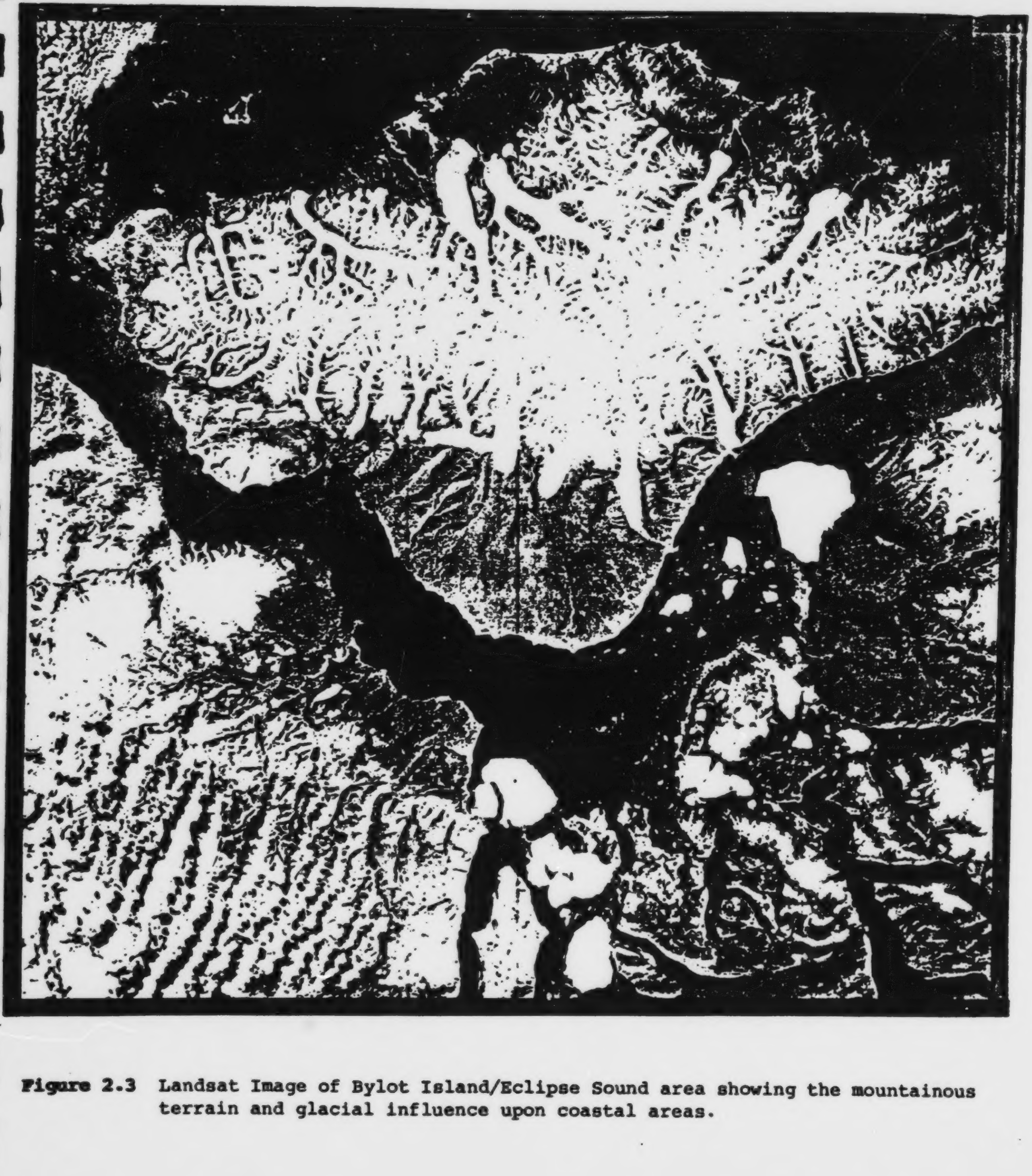


**Figure 2.3** Landsat Image of Bylot Island/Eclipse Sound area showing the mountainous terrain and glacial influence upon coastal areas.

### 2.1.1 Historical Geology

Historically, the region has undergone a series of depositional and erosional sequences separated by unconformities that represent tectonic events; see Table 2.1. The present day surficial geology of the Lancaster Sound/Eclipse Sound area is the culmination of events which began in the late Precambrian over 2000 million years ago. The formation of a near peneplain surface of the shield was subsequently incised with deep valleys from tributary drainage. This erosional surface appears to have been buried by shallow marine sediments and re-exhumed at least once during the Proterozoic (Bostock, 1976). The study area was completely covered by Paleozoic strata and remained predominantly a marine depositional environment until middle Devonian time, 370 million years ago, (Kerr, 1980). Emergence and a long erosional period followed until Tertiary time, with short periods of local deposition within structurally controlled basins (Miall et al, 1980). Continued erosion along with glaciation and the effects of glacial deposition have shaped the present day morphology, (Figure 2.4.)

### 2.1.2 Regional Geology and Geomorphology

The development of Tertiary drainage systems and Pleistocene glaciation are the main events controlling the development of the present day morphology and relief of the area. The location of many of the present day waterways was established prior to the Pleistocene glaciation. The development of this regional drainage pattern had a major controlling influence on the development and erosional patterns of Pleistocene glaciers and subsequently on the development of the present day character of the region. To a large degree, the Pleistocene glaciers followed the already established relief and carved fjords in many of the pre-existing valley systems. Following glaciation and the subsequent rise of relative sea level, the present system of islands, channels and fjords was established.

The Proterozoic and Paleozoic sediments have been eroded from most of eastern Devon, Bylot and Baffin Island, within the study area, exposing the basement shield rocks. The Proterozoic strata remain along the north and west coasts of Bylot Island and along most of Milne Inlet to the south.

Table 2.1 Age of Sequences in the Bylot Island/Eclipse Sound Study Area, after Kerr, 1980. Shading Indicates Missing Rocks, Corresponding to Periods of Erosion.

| AGE | | STUDY AREA |
|---|---|---|
| QUAT ERNARY | RECENT | ▨ |
| | PLEISTOCENE | ▨ |
| TERTIARY | PLIOCENE | ▨ |
| | MIOCENE | ▨ |
| | OLIGOCENE | ▨ |
| | EOCENE | ▨ |
| | PALEOCENE | ▨ |
| CRETA CEOUS | LATE | |
| | EARLY | ▨ |
| JURAS SIC | LATE | ▨ |
| | MIDDLE | ▨ |
| | EARLY | ▨ |
| TRIAS SIC | LATE | ▨ |
| | MIDDLE | ▨ |
| | EARLY | ▨ |
| PER MIAN | LATE | ▨ |
| | EARLY | ▨ |
| PENN. | LATE | ▨ |
| | MIDDLE | ▨ |
| | EARLY | ▨ |
| MISS. | LATE | ▨ |
| | EARLY | ▨ |
| DEVO NIAN | LATE | ▨ |
| | MIDDLE | ▨ |
| | EARLY | ▨ |
| SILU RIAN | LATE | |
| | MIDDLE | |
| | EARLY | |
| ORDO VICIAN | LATE | |
| | MIDDLE | |
| | EARLY | |
| CAM BRIAN | LATE | |
| | MIDDLE | |
| | EARLY | ▨ |
| PROTER OZOIC | HADRYNIAN | ▨ |
| | HELIKIAN | |
| | APHEBIAN | ▨<br>(SHIELD) |

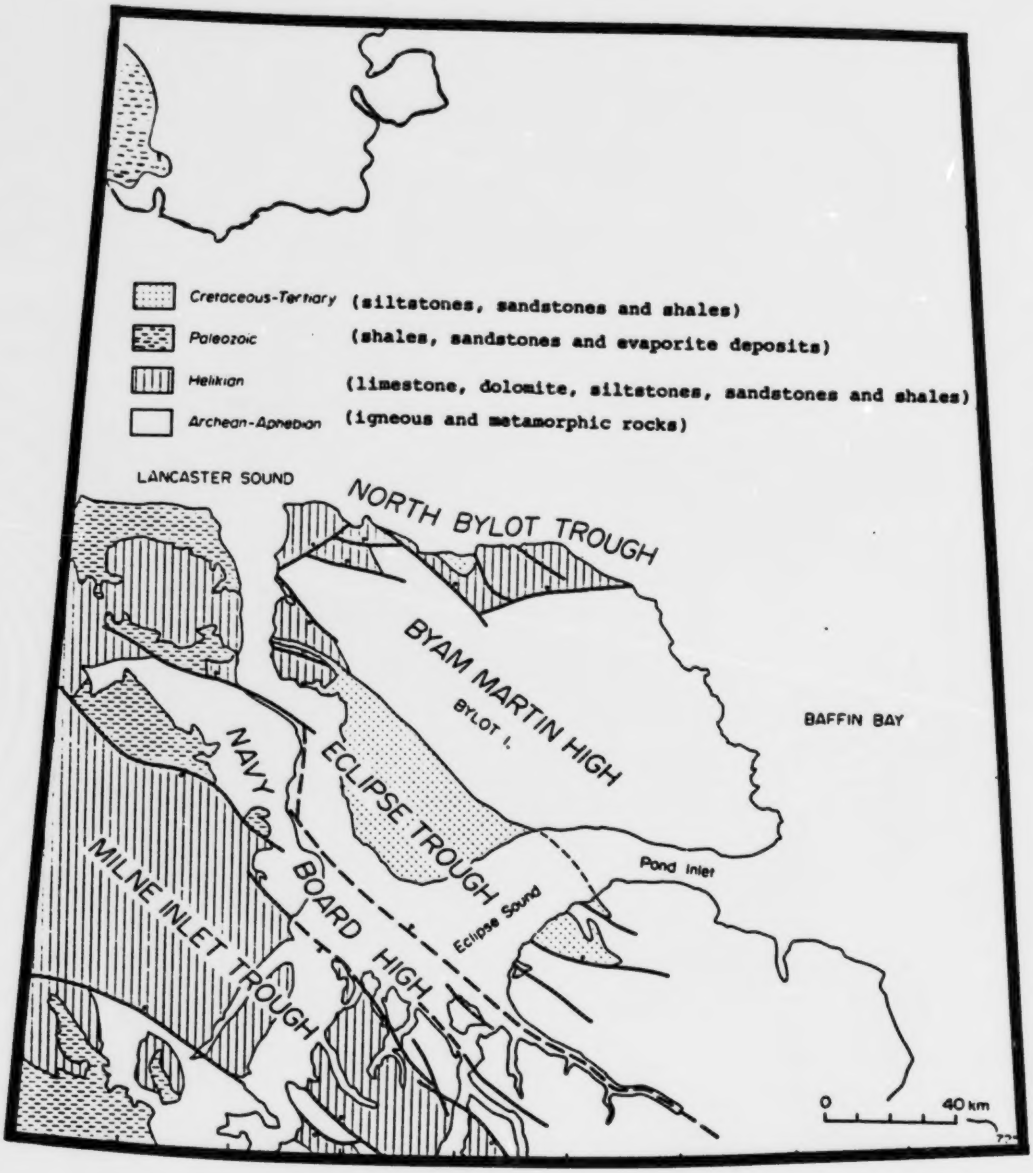

Cretaceous-Tertiary (siltstones, sandstones and shales)
Paleozoic (shales, sandstones and evaporite deposits)
Helikian (limestone, dolomite, siltstones, sandstones and shales)
Archean-Aphebian (igneous and metamorphic rocks)
LANCASTER SOUND
NORTH BYLOT TROUGH
BYAM MARTIN HIGH
BYLOT I.
BAFFIN BAY
NAVY
BOARD
HIGH
ECLIPSE TROUGH
MILNE INLET TROUGH
Pond Inlet
Eclipse Sound
0
40 km

**Figure 2.4** Regional geological setting. Modified from Kerr, 1980 (after Jackson et al., 1975).

Few Paleozoic sediments remain within the study area, the only exposure is along the north coast of the Borden Peninsula; however, these sediments make up most of the coastal geology of the islands to the west. Cretaceous sediments crop out along the southwest corner of Bylot Island and around the community of Pond Inlet.

The subsurface geology and physiography of the marine environment are inferred from seismic records obtained from oil exploration in Lancaster Sound and from similarities between stratigraphic sequences along the surrounding coastlines. In general there is little difference between the structure of the marine regions and that of the coastal areas. Characteristically the marine areas are the result of structural lows, typically down faulted blocks, whereas coastal areas are formed by structural highs. The four major geological sequences: the basement shield formation, Proterozoic marine strata, Paleozoic marine strata and Cretaceous sediments can be traced into the marine regions. The shield rocks underlie the entire region and are the dominant controlling factor on most of the structural patterns in the area. The Proterozoic sediments thin and are truncated northward, as evidenced by their presence on northwestern Baffin and Bylot Island, but their absence on southeastern Devon Island (Kerr, 1980). The exact location of the northern extent of these rocks under Lancaster Sound is not precisely known. The depositional environment of the Paleozoic strata and their substantial presence along northwestern Baffin Island and western Devon Island suggests that their presence under Lancaster Sound is almost certain, however, Navy Board Inlet and Eclipse Sound are dominated by Proterozoic structures and the presence of Paleozoic sequences under these water areas is less likely. Seismic profiles in Lancaster Sound suggest that thick sequences of unconsolidated to poorly consolidated sediments are found in considerable thickness. These sediments are inferred to be Cretaceous to Recent in age (Figure 2.5). Similar sedimentary deposits are inferred in the basins of Eclipse Sound and Pond Inlet. A cross-sectional profile across Lancaster Sound from Devon Island to northeast Baffin Island (Figure 2.6) clearly shows this structural and geological relationship.

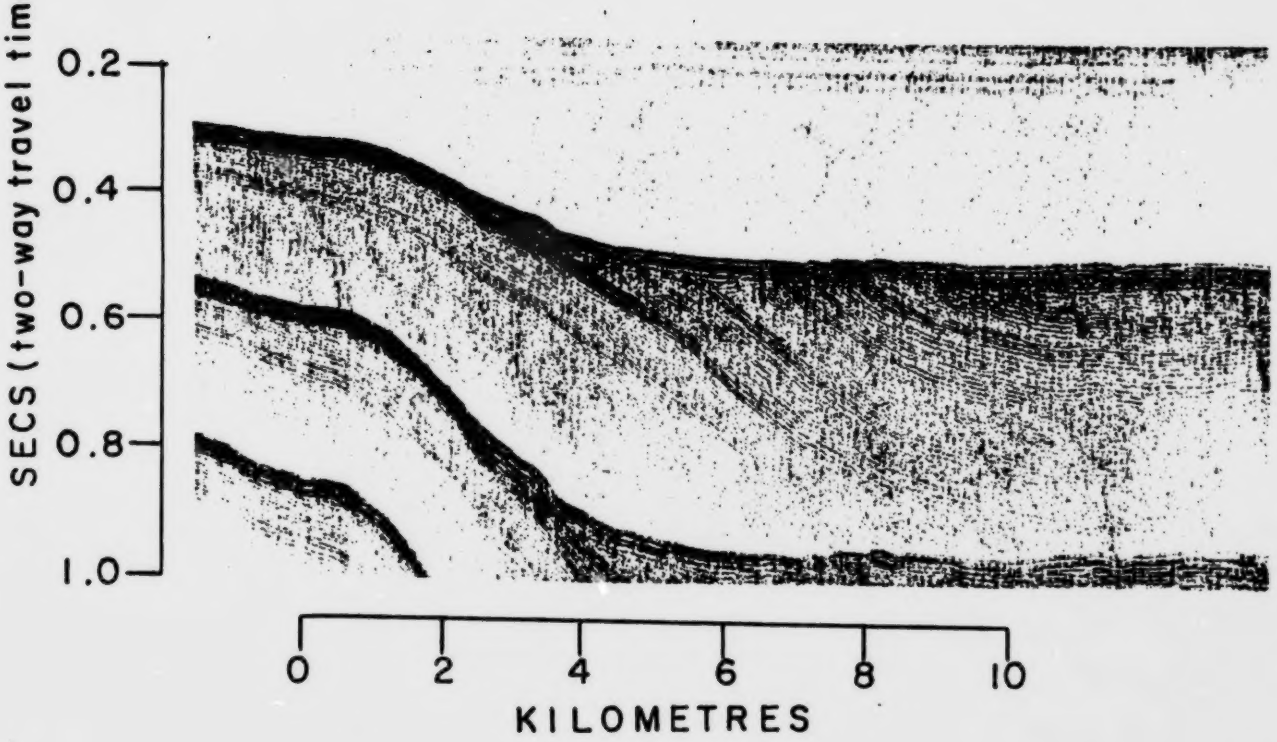


**Figure 2.5** Air gun seismic reflection record from western Lancaster Sound south of Radstock Bay. The profile crosses the northern rim of Barrow Basin and shows Paleozoic carbonate rocks in the north (at left) overlain by Mesozoic-Tertiary clastics in the basin (at right) (after Lewis et al., 1977).

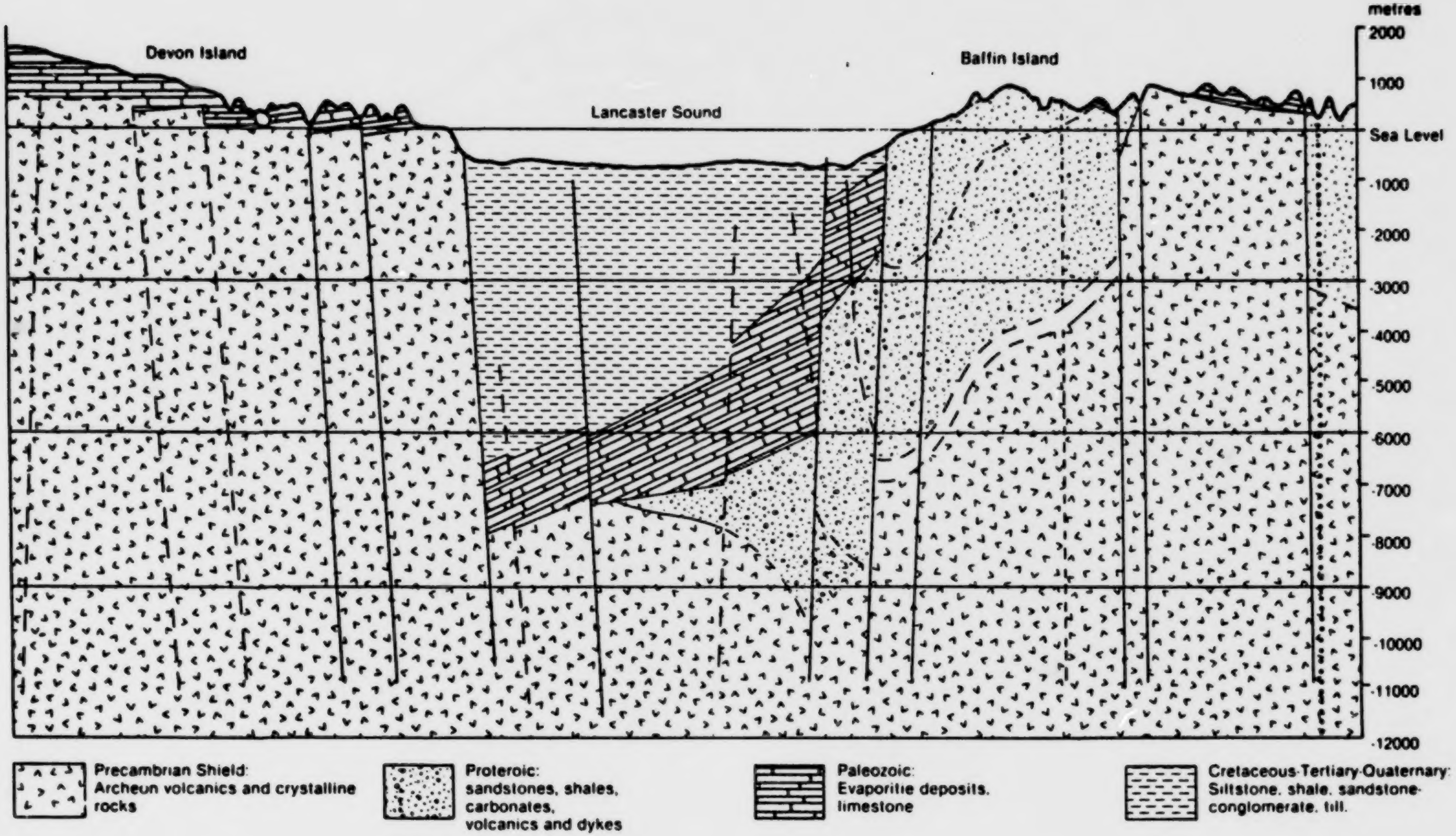

Devon Island
Lancaster Sound
Baffin Island
metres
2000
1000
Sea Level
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-8000
-9000
-10000
-11000
-12000
Precambrian Shield: Archeun volcanics and crystalline rocks
Proteroic: sandstones, shales, carbonates, volcanics and dykes
Paleozoic: Evaporitie deposits, limestone
Cretaceous-Tertiary-Quaternary: Siltstone, shale, sandstone-conglomerate, till.

**Figure 2.6** Structural geology of Lancaster Sound and coastal areas of Devon and northeast Baffin Islands (after Kerr, 1980).

### 2.1.3 Coastal Geology and Morphology

Pleistocene to Recent events have been the most critical to the development of the present coastal character. The erosional effects of the ice sheets and valley glaciers have been and continue to be a factor in both bedrock erosion and in subsequent deposition of large amounts of glacial sediments. Considerable volumes of sediment were eroded and deposited where the glaciers and ice sheets moved across relatively unresistant sedimentary strata. This has resulted in abundant glacial or fluvial-glacial deposits being available along the coast. These include, in particular, large glacial outwash deposits and associated relict and active meltwater drainage channels. Many of these channels terminate along the coast in large deltaic or estuarine features actively supplying sediment to the beaches and nearshore areas. In addition, the relative sea level changes which resulted from isostatic-eustatic fluctations associated with deglaciation have had a major impact on the present day coastal character.

The basic characteristics of the coastline within the Lancaster Sound/Eclipse Sound region are closely controlled by the underlying bedrock and geological structural characteristics. Because of this the coastal landforms are discussed in relationship to the present geology of the area (Figure 2.4) and are summarized in Figure 2.7

A reference map of the study area which includes place names and features discussed in the text is included as Figure 2.8. Additional detailed summary information is included on a) the percentage of continuous beaches, b) the dominant beach substrate types, c) backshore slope and d) backshore material. These are presented in figures 2.9 to 2.12 respectively.

The following coastal descriptions have been organized initially by the four rock types located within the region, a) Precambrian, b) Proterozoic, c) Paleozoic, and d) Cretaceous and Tertiary. Secondly, within each rock type, coastwise desciptions of the shorezone character are given in relationship to the underlying geology.

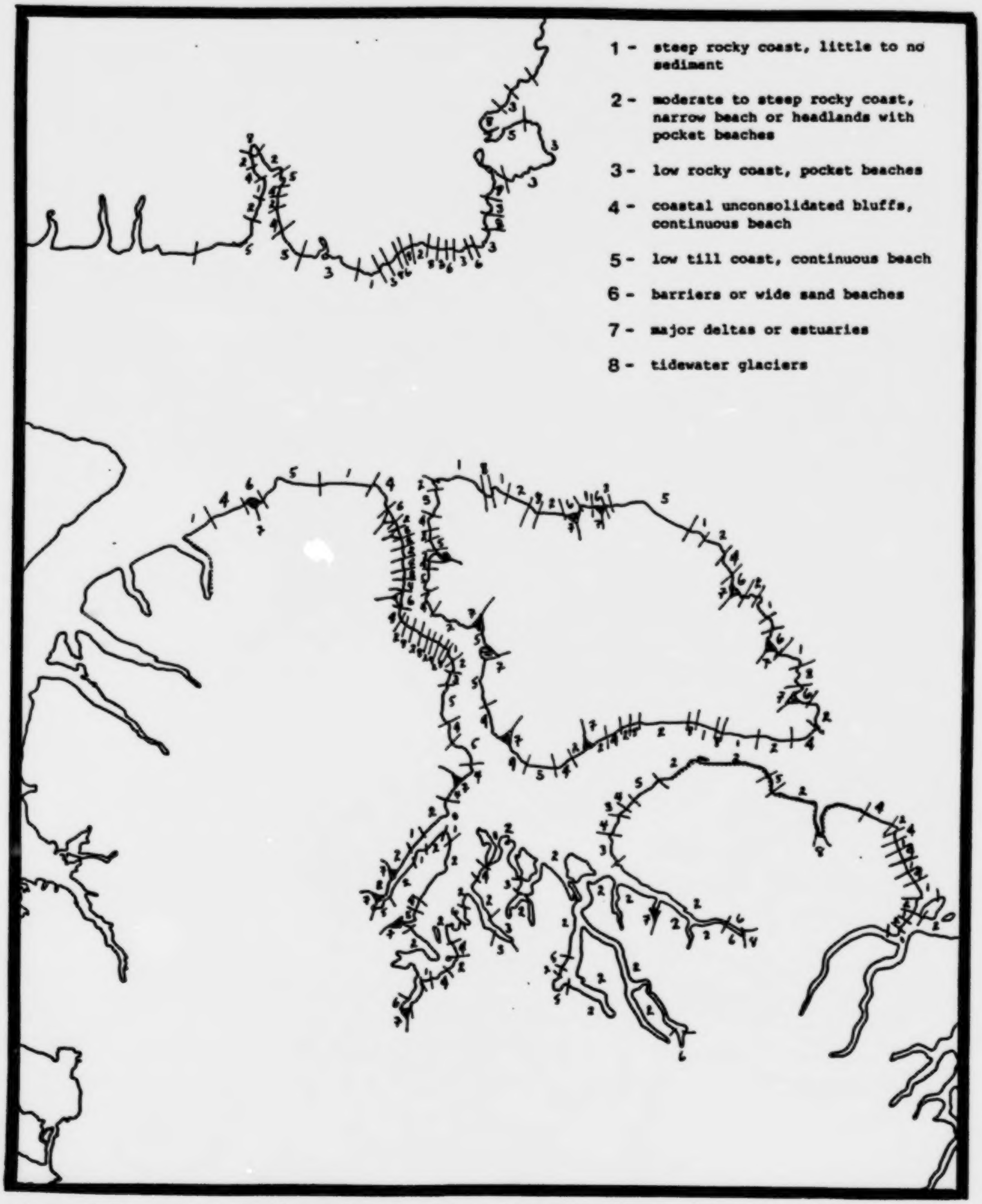

1 - steep rocky coast, little to no sediment
2 - moderate to steep rocky coast, narrow beach or headlands with pocket beaches
3 - low rocky coast, pocket beaches
4 - coastal unconsolidated bluffs, continuous beach
5 - low till coast, continuous beach
6 - barriers or wide sand beaches
7 - major deltas or estuaries
8 - tidewater glaciers

**Figure 2.7** Coastal physiography of eastern Lancaster Sound, Navy Board Inlet, Pond Inlet and the Eclipse Sound region.

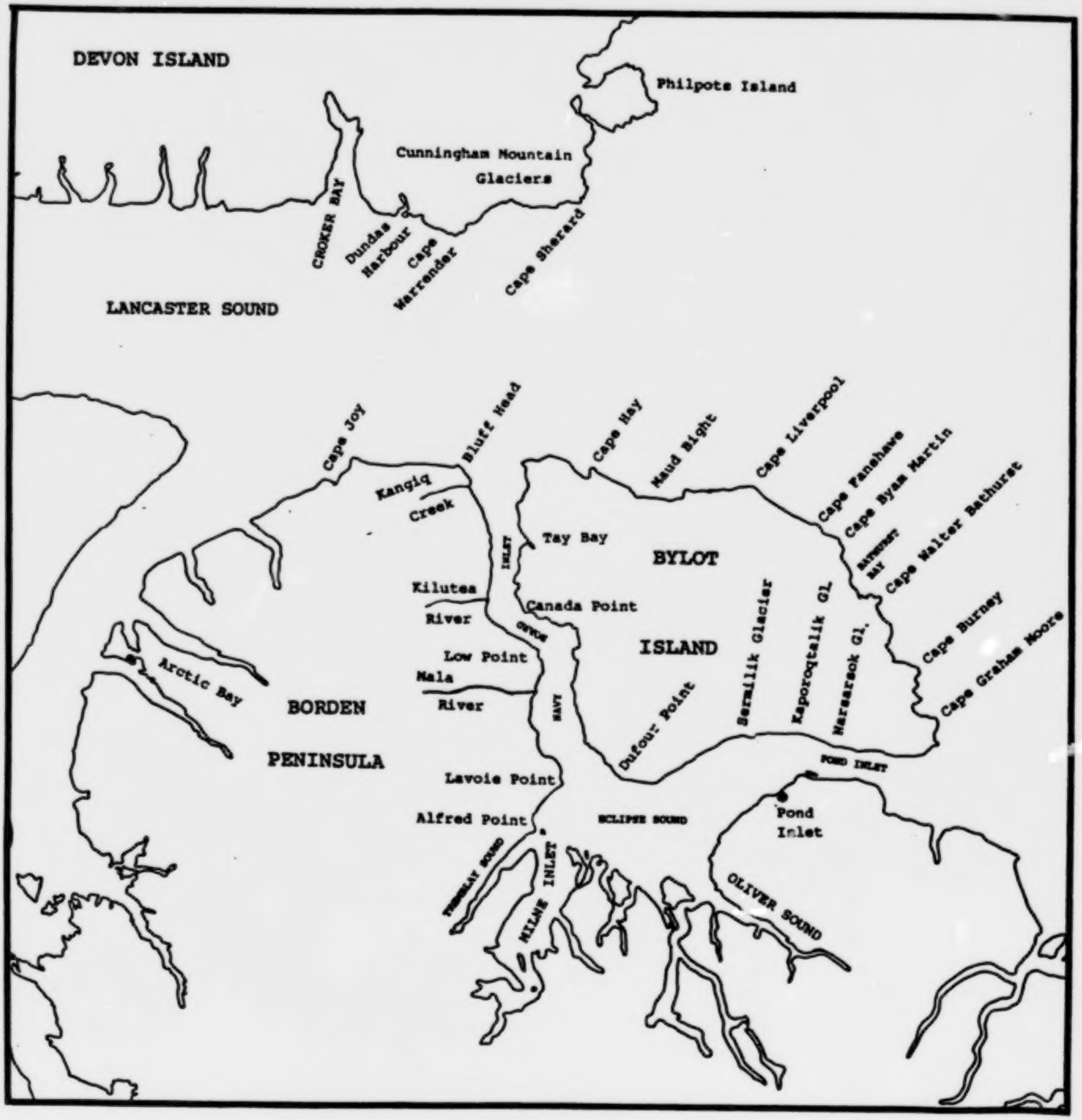

DEVON ISLAND
Philpots Island
Cunningham Mountain Glaciers
CROKER BAY
Dundas Harbour
Cape Warrender
Cape Sherard
LANCASTER SOUND
Cape Joy
Bluff Head
Kangiq Creek
Cape Hay
Maud Bight
Cape Liverpool
Cape Fanshawe
Cape Byam Martin
BATHURST BAY
Cape Walter Bathurst
Tay Bay
INLET
BYLOT
Kilutea River
Canada Point
BOARD
Low Point
Mala River
ISLAND
Sermilik Glacier
Kaporoqtalik Gl.
Narsarsok Gl.
Cape Burney
Cape Graham Moore
Arctic Bay
BORDEN
PENINSULA
NAVY
Dufour Point
POND INLET
Lavoie Point
Alfred Point
ECLIPSE SOUND
Pond Inlet
TREMBLAY SOUND
MILNE INLET
OLIVER SOUND

Figure 2.8 Reference map of place names and descriptive features.

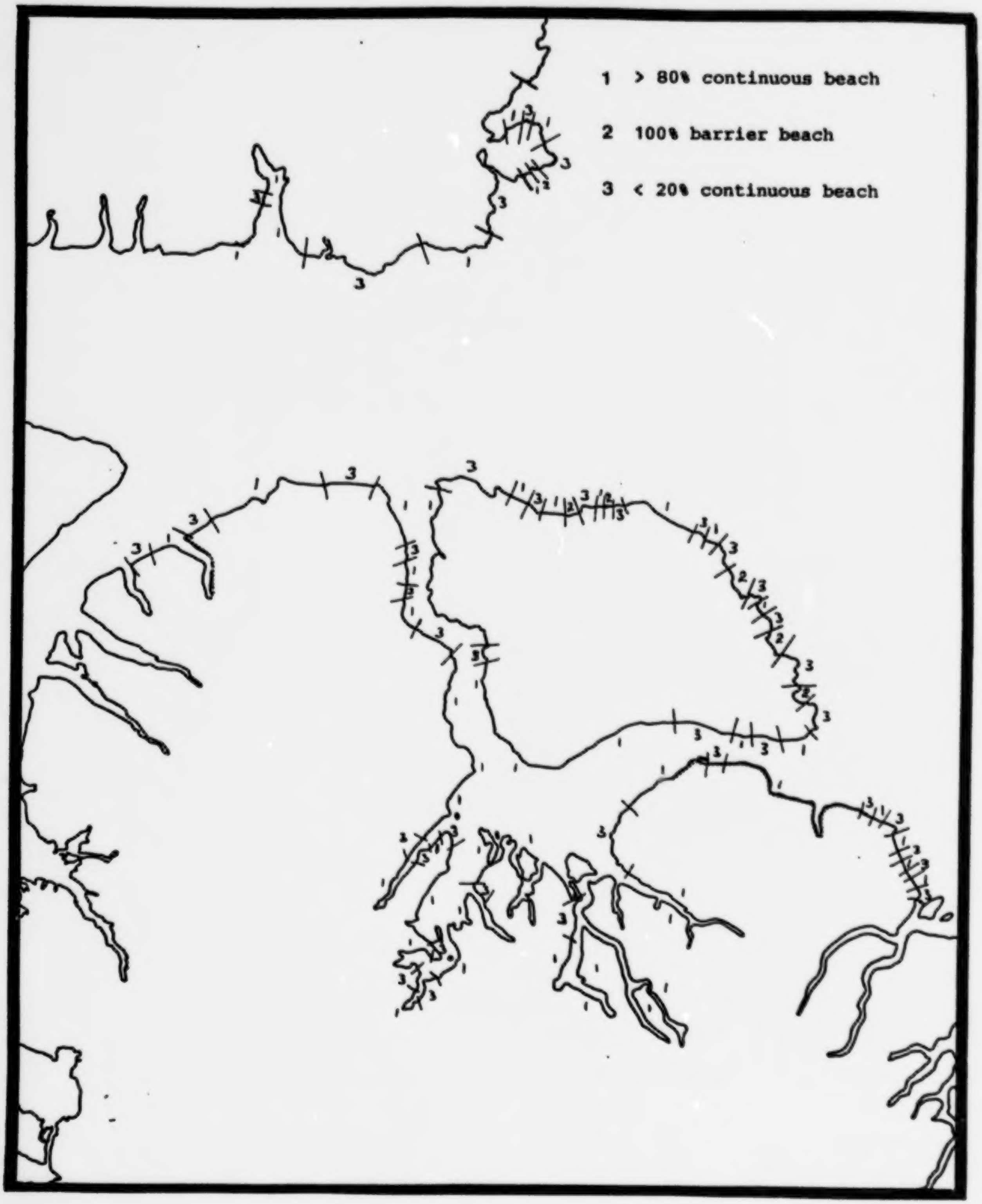

1 > 80% continuous beach
2 100% barrier beach
3 < 20% continuous beach

Figure 2.9 Percentage of continuous beach (after Petro-Canada, 1982).

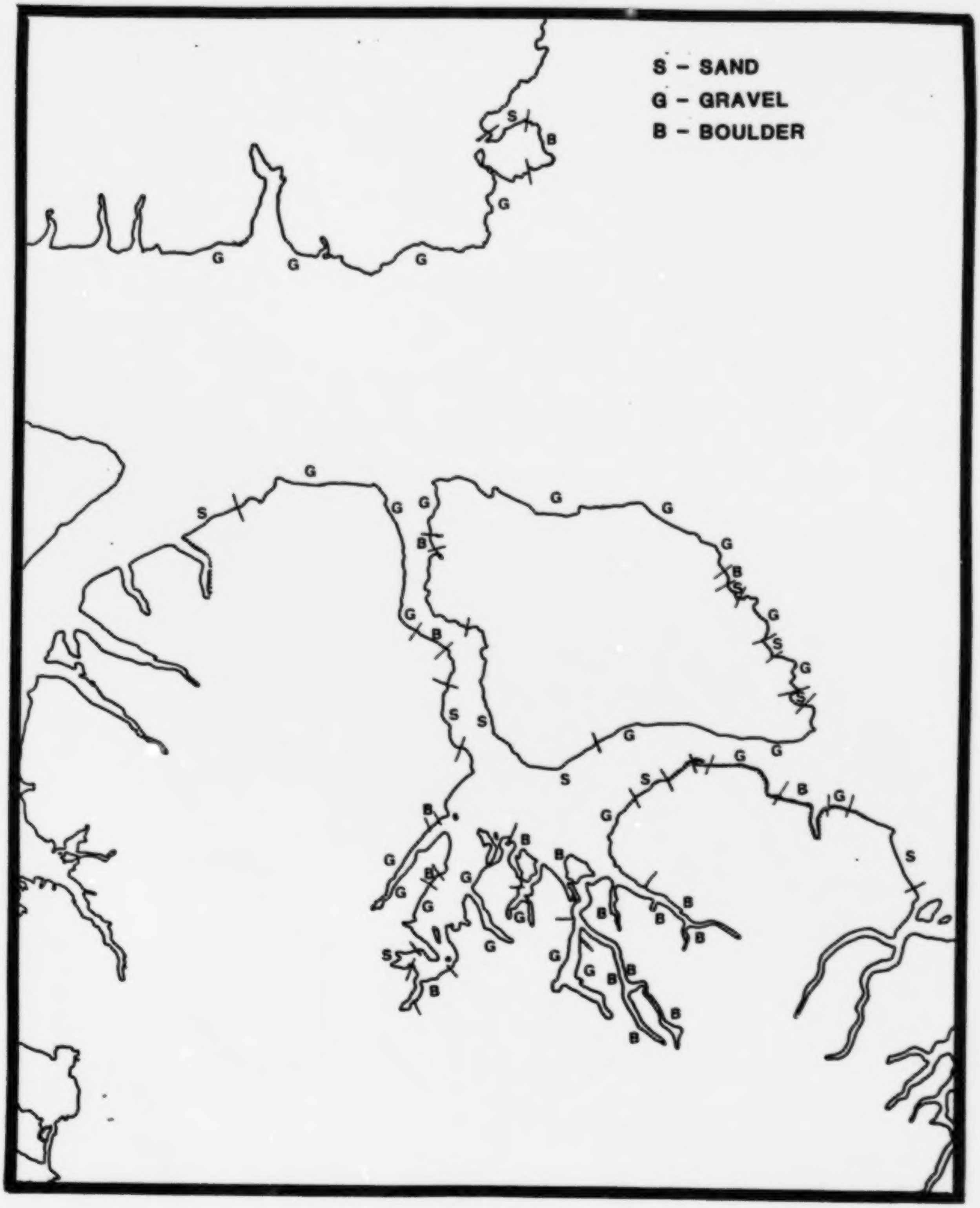

S - SAND
G - GRAVEL
B - BOULDER

Figure 2.10 Dominant beach substrate types (after Petro-Canada, 1982).

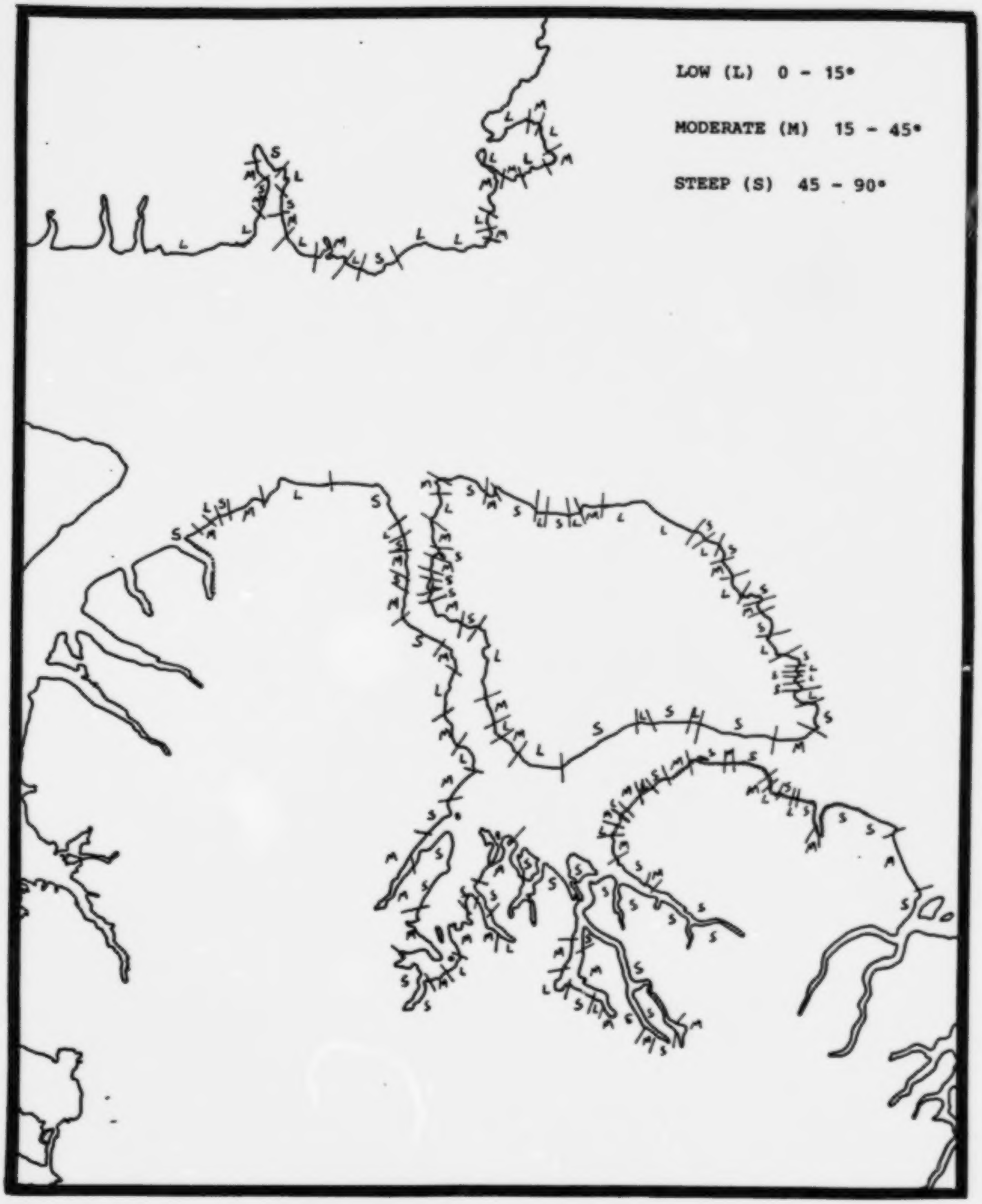

LOW (L) 0 - 15°
MODERATE (M) 15 - 45°
STEEP (S) 45 - 90°

Figure 2.11 Backshore slope (after Petro-Canada, 1982).

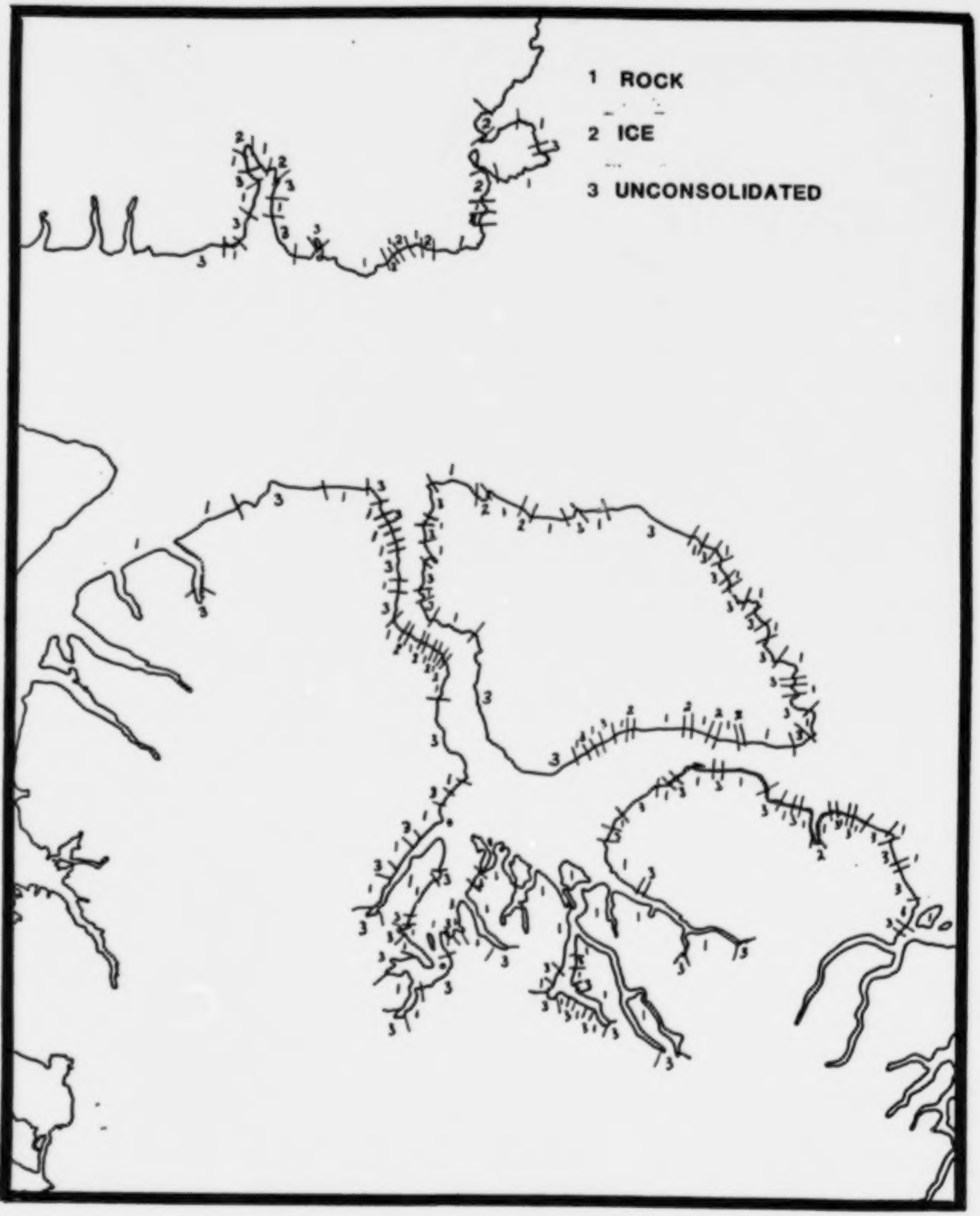

1 ROCK
2 ICE
3 UNCONSOLIDATED

Figure 2.12 Backshore material (after Petro-Canada, 1982).

## Precambrian Geology

The foundation of the region is part of the Precambrian Shield, a crystalline basement complex made up of igneous and metamorphic rocks of Aphebian age and belong to the Churchill Province of the shield (Stockwell et al, 1970). Exposures of these basement rocks form the coastline of eastern Devon Island, eastern Bylot Island, the southwest coast of Navy Board Inlet, the head of Milne Inlet, and the southern shoreline of Eclipse Sound and Pond Inlet east of Cape Hatt, including the northern portions of Tay Sound and Paquet Bay, and all of Oliver Sound. An exception to this is a region centred on the community of Pond Inlet which is underlain by more recent sedimentary strata.

The southeastern coast of Devon Island from Dundas Harbour east to Cape Warrander is characterized by steep cliffs forming rocky headlands and gravel pocket beaches. East to Cape Sherard the cliff coast is interrupted by four major valley glaciers, seaward extensions of the Devon Island ice cap, within the Cunningham mountains to the north. Present continuous beaches, relict raised beaches and multiple recurve spit complexes are common along this section of coast having been supplied with abundant glacial outwash material. The backshore elevations decrease to the northeast forming a coastal lowland of glacial rubble in conjunction with the Devon Island ice cap, which extends around the coast of Philpots Island, a low rocky ice-scoured peninsula protruding into Baffin Bay.

The Precambrian rocks along the east coast of Bylot Island from Cape Fanshawe around to the Sermilik Glacier are eroded and dissected into rounded hills separated by wide valleys. Rocky areas are characterized by steep backshores, either devoid of sediments or fringed by coarse gravel and boulder beaches. Valley floors contain extensive outwash material from nearby valley glaciers and meltwater streams terminate in broad delta-lagoon systems with extensive barrier beaches along the coast. Three large delta-lagoon-barrier systems extend along the east coast of Bylot Island separated by rocky headlands at Cape Byam Martin, Cape Walter

Bathurst, Cape Burney and Cape Graham Moore. The largest of these is between Cape Byam Martin and Cape Walter Bathurst forming the head of Bathurst Bay with continuous barrier beaches extending over 7 km along the shoreline. Along the southwest coast of Navy Board Inlet from the Kilutea River south to Low Point the steep rocky coast is almost devoid of sediment and is dissected by four valley glacier tonques which cut across the shore zone. South to Alfred Point the coastline takes on a different character. The slope of the rocky backshore decreases and the shore zone is dominated by unconsolidated glacial sediments overlying the bedrock and extensively reworked by marine processes along the coast. At the head of Milne Inlet and along the shoreline of Eclipse Sound and Pond Inlet the backshore steepens and bedrock headlands become frequent at the shoreline. They are often fringed by talus deposits at their base and beaches are generally coarse, made up of gravel and boulders. Where major tributary valleys reach the coast, shorelines are more gently sloping and dominated by unconsolidated backshores and wider beaches, the result of abundant drift and alluvium from inland glaciers. The coastline of Oliver Sound is steep and rocky with backshore elevations rising to 300 m within half a km of the shoreline. Beaches are narrow and comprised of mainly boulders and gravel, except at the head of the sound where outwash deposits and moraines dominate the coast below an active valley glacier.

## Proterozoic Geology

The Proterozic rocks are of Helikian age. Within the study area these strata lie unconformably over the older shield rocks (Jackson et al, 1975) and outcrops predominate along the coastline of Milne Inlet, the north shores of Navy Board Inlet and north coast of Bylot Island (Figure 2.4).

The coastlines of Milne Inlet and Tremblay Sound are generally steep and rocky. The shoreline is comprised of continuous gravel and boulder beaches with a few rocky headlands. Gentle backshore slopes and unconsolidated deposits are associated with major tributary valleys that follow a northwest - southeast structural pattern perpendicular to the trend of the coast, and bring alluvial and glacial material to the shore zone. On the western shore of Navy Board Inlet, between the Kilutea River and Kangiq Creek to the north, the coastline consists predominately of a moderately sloping unconsolidated backshore fronted by continuous gravel and sand beaches. Outcrops of the underlying Proterozoic rocks form steep rocky headlands and intermittent coastal sections often devoid of sediments. The northeastern shore of Navy Board Inlet from Canada Point north to Tay Bay is characterized by a coastal plateau which drops steeply near the coast. The backshore is glacial till which is reworked locally, producing continuous beaches along the coast. A series of valleys perpendicular to the coast have been cut through the plateau by meltwater discharge from glaciers of the Byam Martin mountains to the east. On the northwestern corner of Bylot Island around to Cape Hay, this coastal plateau rises to form a broad triangular lowland; the shore zone is devoid of sediments and backed by near vertical cliffs. Near Cape Hay the shore is completely obscured by a large valley glacier calving into the sea. East into Maud Bight the backshore cliffs are cut by steep sided valleys and fringed by continuous beaches. The western edge of Maud Bight is dominated by another large glacier extending into the shorezone and on the east by a large delta complex. Further east to Cape Fanshawe the coastal relief decreases and bedrock outcrops are less frequent. The backshore is till-covered and cut by meltwater drainage from the ice cap to the south. Continuous coarse beaches front eroding coastal bluffs and spit-lagoon complexes are common at the mouths of drainage channels.

## Paleozoic Geology

Paleozoic rocks are of Ordovician and Silurian age and consist of shales, quartz, sandstones, evaporite deposits such as salt and gypsum and limestones, some of which are abundantly fossiliferous (Pelletier 1980). Paleozoic rocks occur only between Bluff Head and Cape Joy, on

Borden Peninsula. The coastline of this area is characterized by continuous coarse sediment beaches and raised beach ridges backed by discontinuous cliffs and slopes which rise 100 feet to a coastal lowland plateau.

### Cretaceous and Tertiary Geology

Cretaceous and Tertiary rocks are the youngest rocks within the study area and are predominately siltstones, sandstones and shales with minor coal. The lower units in the sequence consist of quartz sandstones, a sheet-like deposit which may represent a beach or shallow platform depositional environment (Kerr, 1980). These lower deposits range in thickness from 10 to 120 m, thinning to the southwest on Bylot Island. This sequence is overlain by marine shales of up to 1130 m (Miall et al, 1980). These rocks outcrop within a region centred around southwest Bylot Island, extending from south of Canada Point around to the Sermilik Glacier in Eclipse Sound. They are also found as an island of sedimentary strata surrounded by the basement crystaline complex of the Shield around the community of Pond Inlet on the southeastern shore of Eclipse Sound. The location of these deposits coincides with Eclipse Trough, a fault-controlled feature which underlies the southwest Bylot Island and Eclipse Sound area. The coastline of southwest Bylot Island is characterized by a broad lowland, gently sloping inland to the Byam Martin mountains to the northeast. The shore zone is backed by coastal bluffs 30 to 60 m high and is fronted by continuous sand and gravel beaches. Braided melt-water streams flow across the lowlands and terminate in numerous deltas along the coast.

### 2.1.4 Marine Sediments

With the retreat of the glaciers and subsequent submergence of the low terrain with rising sea levels, marine sedimentation resumed. This was particularly important in Lancaster Sound. Currents scouring the seabed in Barrow Strait to the west eroded the finer sediments and transported them eastward. These finer sediments were deposited along Lancaster Sound and reach a thickness of over 200 m at the entrance to Baffin Bay (Pelletier 1980).

Most of the inlets and fjords contain coarse sediments such as cobbles, gravel and boulders along the coast, with deposits of sand, silts and clays offshore. The deeper basin deposits are generally undisturbed silts and clays; however, evidence exists of slumping and turbidity flows originating from steep fjord walls and of ice scour on bottom sediments in Lancaster Sound (Figure 2.13). Nearshore regions are more influenced by waves and currents and receive material directly from terrestrial erosion. The heads of fjords and bays are commonly characterized by large delta complexes, often with active glaciers. The deeply incised valleys characteristic of the shield rocks on Bylot Island and northeastern Baffin Island terminate in large estuarine/delta features which extend for several kilometers offshore and supply large amounts of alluvium to the marine environments.

The modern bottom sediments are predominantly ice-rafted and marine in origin, however, in coastal areas a substantial portion of material is derived from rivers and eroding coastal deposits. The distribution of marine sediments in the study area (Figure 2.14) shows a general transition from coarse sediments near the coastal zone, fining to marine clays over deeper basin floors.

### 2.1.5 Bathymetry

The general character of the sounds, inlets and bays which comprise the study region is similar to that of the surrounding coastal terrain. Nearshore submarine slopes are steep with depths that exceed 100 m in almost all areas within 1 km of the coastline (Figure 2.15). The central portions of the sounds and bays show a generally featureless topography as evidenced by a cross section profile of Lancaster Sound (Figure 2.16). The submarine physiography of the Lancaster Sound/Eclipse Sound region is predominantly controlled by the structural geology of the area. East-west and northwest-southeast fault patterns dominate the area and down-faulted block features are responsible for the formation of the Navy Board Inlet and the main structural influence on eastern Lancaster Sound. The fjord coast of southern Eclipse Sound was formed by localized fault structures along which rivers and glaciers eroded ancient valley floors. A characteristic of some of these inlets is a sill structure which separates the deeper inlet waters from the main Eclipse Sound basin. These sills may

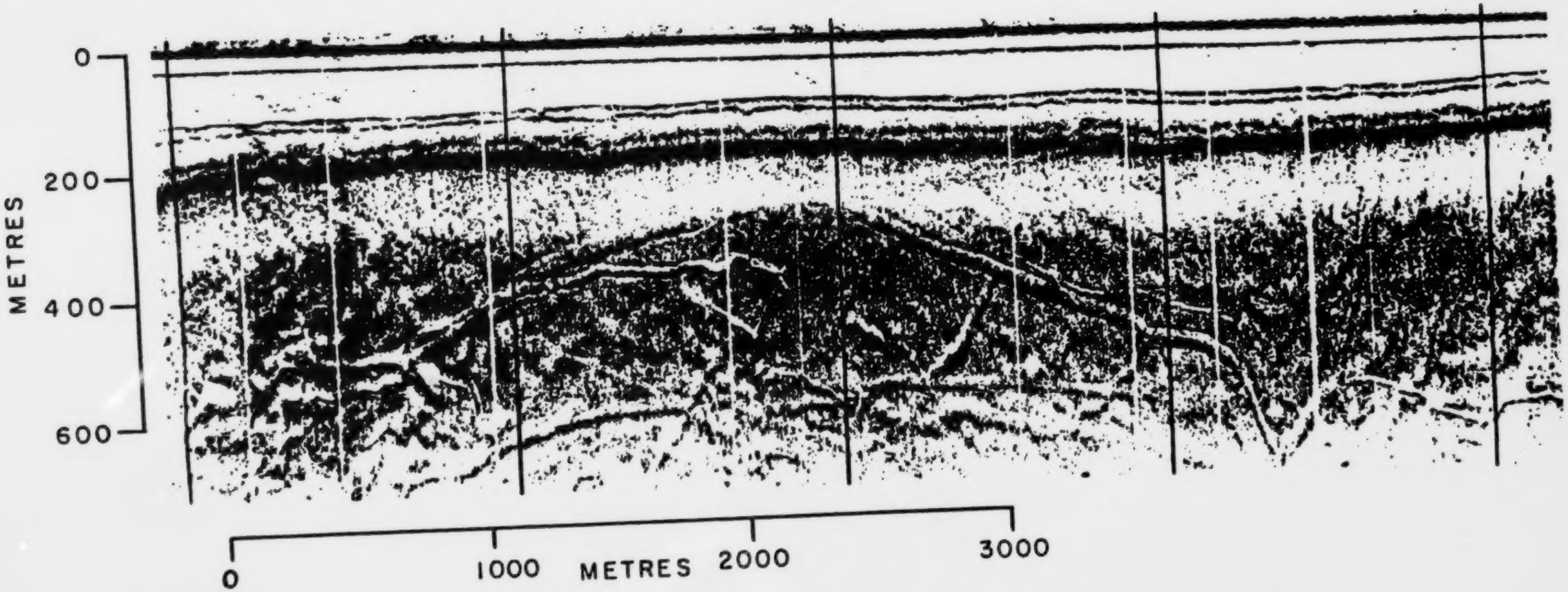

METRES
0
200
400
600
0
1000
METRES
2000
3000

**Figure 2.13** Side-scan sonograph off Fellfoot Point, southeastern Maxwell Bay, Devon Island, in approximately 139 m water depth showing numerous intersecting ice-scour tracks (from Lewis et al, 1977).

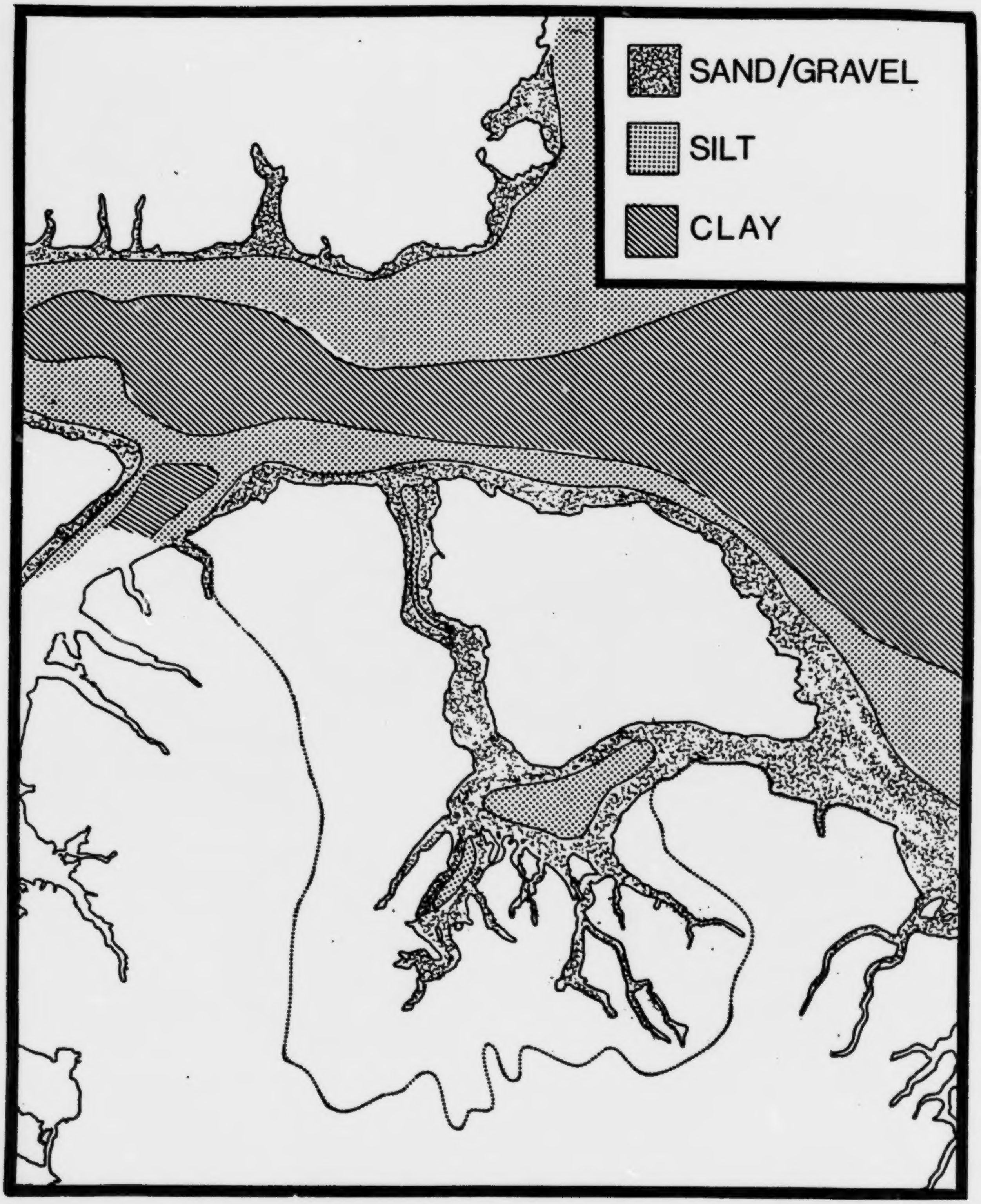

SAND/GRAVEL
SILT
CLAY

**Figure 2.14** Modern marine sediments (after D.I.A.N.D., 1982).

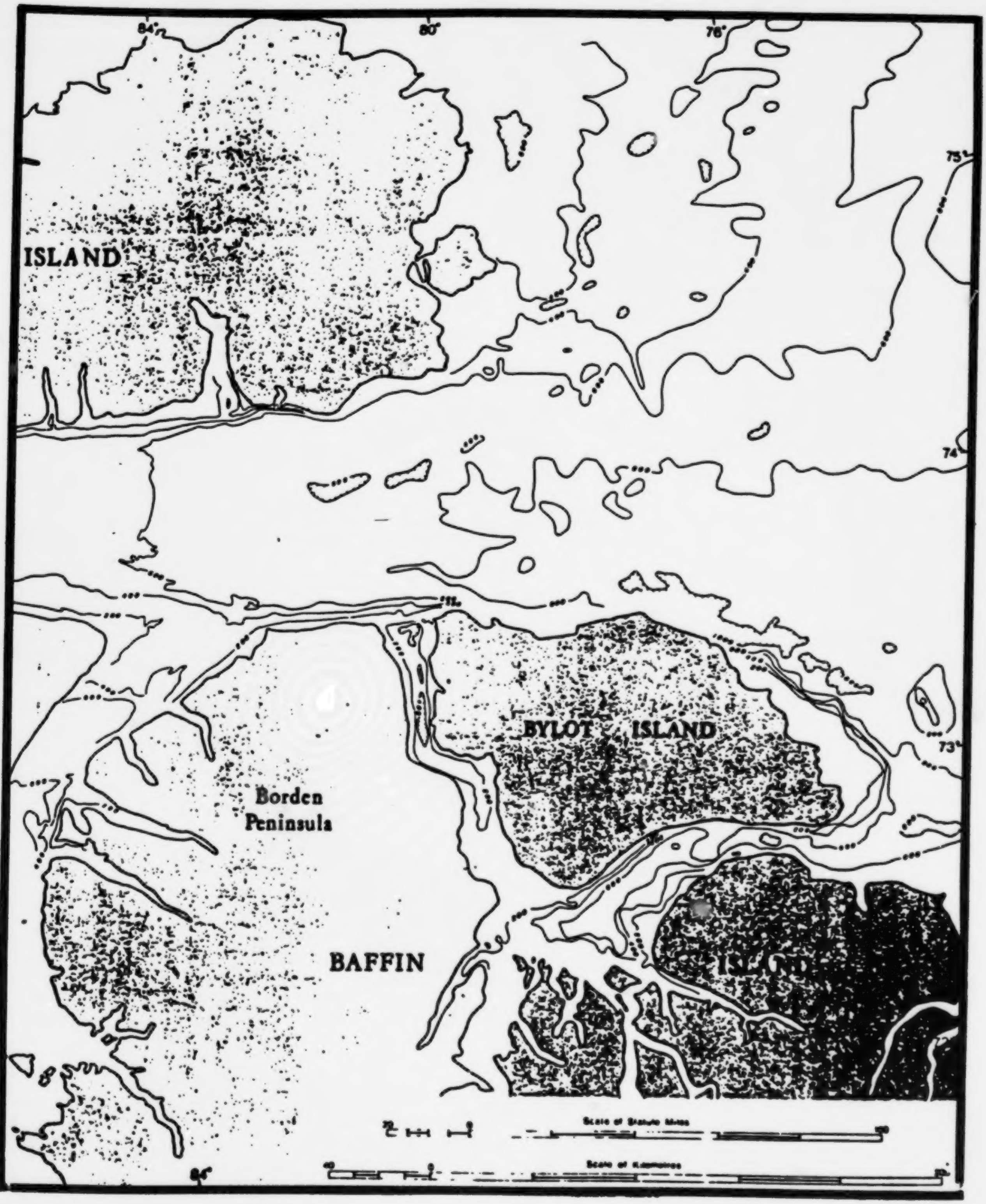

84°
80°
76°
75°
74°
73°
ISLAND
BYLOT ISLAND
Borden Peninsula
BAFFIN
ISLAND
Scale of Statute Miles
Scale of Kilometres
84°

Figure 2.15 Bathymetry in meters of the Lancaster Sound/Eclipse Sound region.

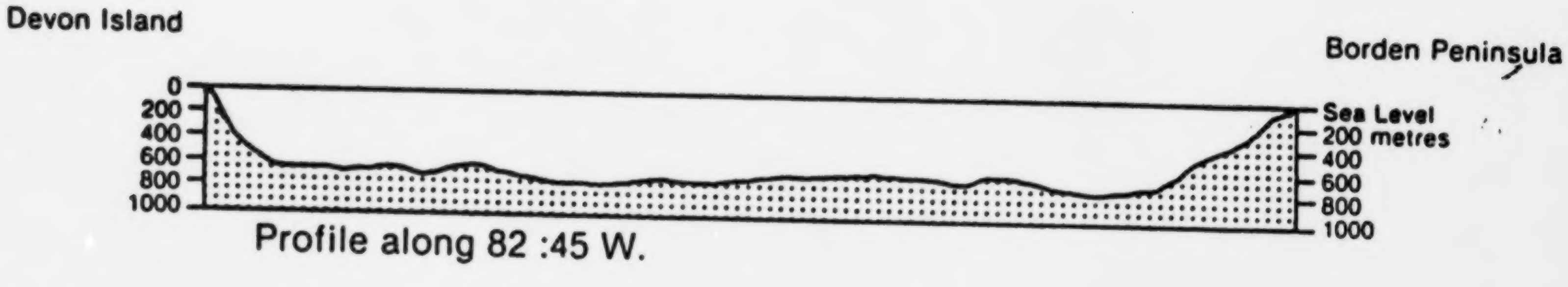


**Figure 2.16** Bathymetry profile across Lancaster Sound (after Pelletier, 1980).

be remnant terminal moraines, a feature typical of deposits originating from valley glaciers. A similar feature is found where Navy Board Inlet enters Lancaster Sound. There is evidence to suggest that this sill actually overhangs Lancaster Sound, and probably represents a hanging valley, a feature which is characteristic of glacially eroded highlands (Pelletier, 1980).

Typical depths of Lancaster Sound within the study area range between 700 and 800 m. The bottom rises northeastward in Baffin Bay and along the east coast of Devon Island and typical offshore depths are in the 400 - 500 m range. Nearshore depths along this coast of Devon Island are not well documented. Southward across Lancaster Sound and eastward along the north coast of Bylot Island and into Baffin Bay the water depths increase to over 1,000 m. Maximum depths are found in a trench along the northeast coast of Bylot Island offshore of Cape Liverpool and Cape Fanshawe. This trench has the greatest depths in the study area with a maximum of 1083 m less than 2 km off the coast. Depths decrease gradually eastward into Baffin Bay and more rapidly southward along the coast of Bylot Island, where abundant outwash material from inland ice sheets has formed delta and barrier island complexes along the coast.

The bathymetry of the inland waters of Navy Board Inlet, Pond Inlet and Eclipse Sound shows a close correlation to Pleistocene glacial activity. Typical depths in Pond Inlet and eastern Eclipse Sound associated with the shield rocks are 600 - 800 m with a maximum of 978 m just northeast of the community of Pond Inlet. Typical depths in Navy Board Inlet and western Eclipse Sound are 200 - 300 m. The presence of Pleistocene glacial deposits is evident in the formation of sills at the mouths of the southern fjord inlets and more dramatically where Navy Board Inlet meets Lancaster Sound. Here the sill depth is reduced to 24 m in the centre of the inlet, but quickly drops off to the north. A less pronounced sill can also be found at the mouth of Pond Inlet where depths are less than 600 m in contrast to the greater than 800 m depths within the basin to the west.

### 2.1.6 Outstanding Marine Geological Features

There are two major geologic/physiographic features of this area. The first is the tide-water glacier area of southeastern Devon Island. Although there are other sections of coastline in North America with tide-water glaciers, this section of southeastern Devon Island is the only segment with a tide-water ice sheet, over 30 km in length.

The other outstanding physiographic feature of the region is the very high coastal relief, particularly along the fjord coast of northeastern Baffin Island where near vertical cliffs in excess of 100 m in height occur. The high relief, sedimentary strata (in southeastern Eclipse Sound), and lack of vegetation accentuate the coastal geology, resulting in a spectacular coastal landscape.

## 2.2 OCEANOGRAPHY

### 2.2.1 Wave Exposure

Surface waves are strongly attenuated in the presence of drifting pack ice and are absent under land fast ice. No description of the wave climate in a high latitude region, therefore, is complete without reference to the ice conditions.

Between the end of October and the end of May the entire region has on the average at least 9/10 ice coverage. Wave exposure during this period is negligible. Ice break-up along the north and east shores of Bylot Island is generally complete by early July, while Navy Board Inlet, Eclipse Sound and Pond Inlet generally clear by mid August. It is during these open-water periods that surface waves can be generated locally or propagate into the area.

Average wave heights increase with proximity to Baffin Bay and is classified in terms of three marine areas (Figure 2.17). Figure 2.18 shows

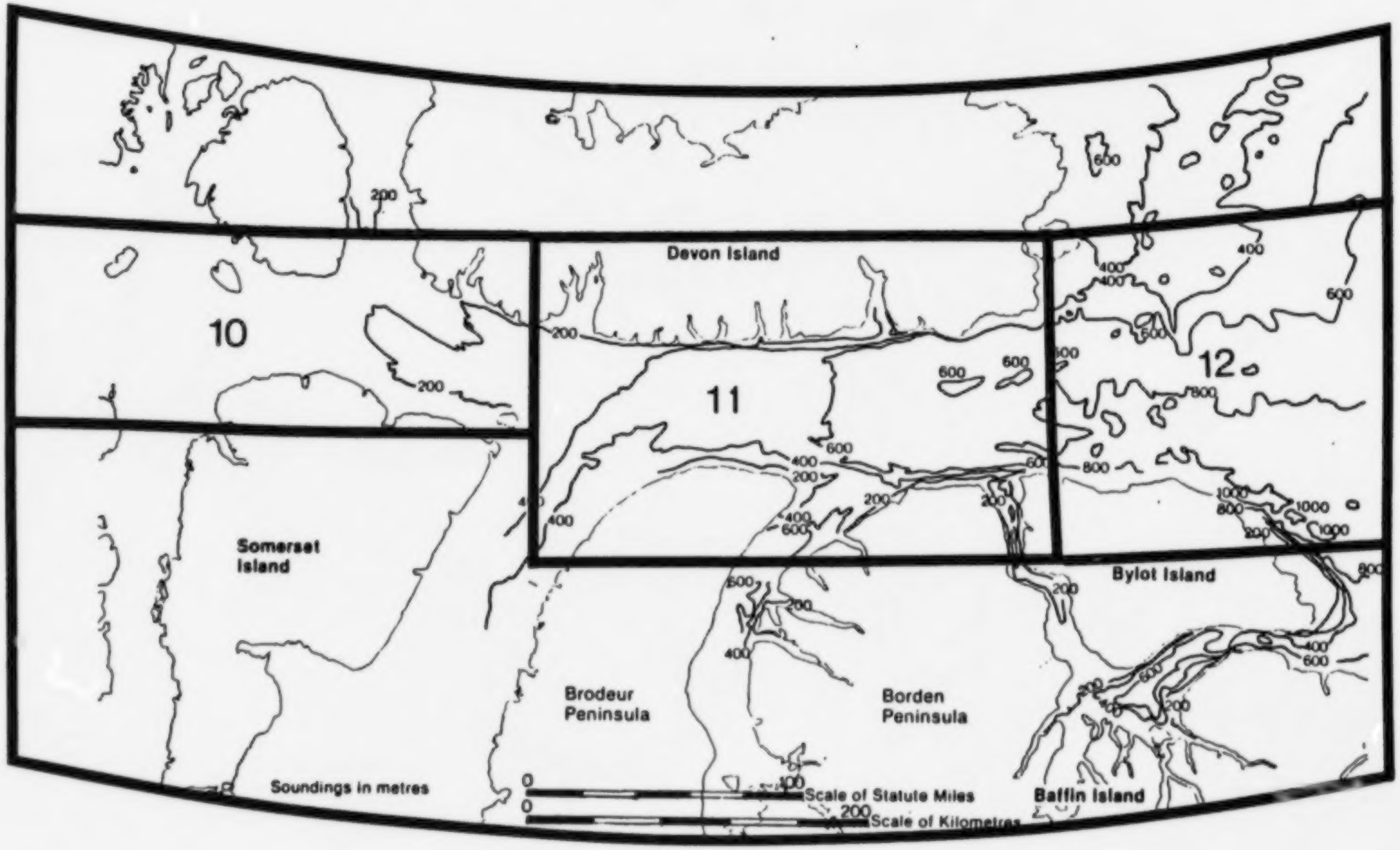

10
11
12
Devon Island
Somerset Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island
Soundings in metres
0 100 Scale of Statute Miles
0 200 Scale of Kilometres
200
400
600
800
1000

Figure 2.17 Location of marine areas, 10, 11, 12. Western, central and eastern Lancaster Sound Respectively.

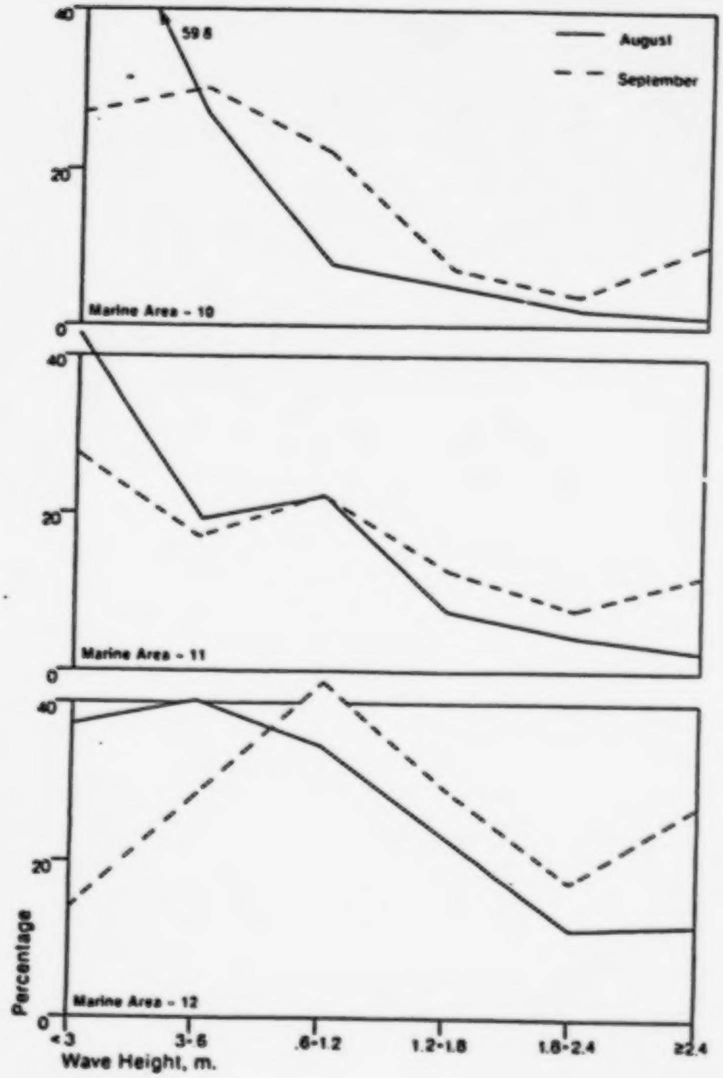


**Figure 2.18** Percentage frequency of occurrence of observed wave heights in marine areas 10, 11 and 12 in, respectively, western, central and eastern Lancaster Sound (from Maxwell, 1980).

the frequency distribution of observed wave heights at marine areas 10, 11, and 12: western, central and eastern Lancaster Sound respectively. Figure 2.19 compares the return period of waves in northeastern Baffin Bay with Lancaster Sound and demonstrates that Lancaster Sound is relatively sheltered. A 6 m significant wave height has a return period of five years in Baffin Bay but the return period for such a wave in Lancaster Sound is 40 years.

To our knowledge no directional wave data for the region are available. However, the largest fetch is from the east and it can be assumed that shorelines facing eastward will be subject to the maximum wave action.

### 2.2.2 Ice

The sea-ice season begins in October when both local formation and advection of unconsolidated pack from the west begins. By the end of October the region is characterized by over 9/10 ice cover. Advection from Barrow Strait, Wellington Channel and Prince Regent Inlet continues until early January. By March the average first year ice thickness is 2 m.

Break up begins in the region of the North Water Polynya in northern-most Baffin Bay. By the end of May there is 7/10 to 8/10 ice coverage east of Devon Island. The ice clears from northeastern Lancaster Sound first, then the western sound clears and finally the southern shores, by early July. This pattern closely parallels the intrusive flow of the Baffin Current. The land-fast ice in Eclipse Sound, Navy Board and Pond Inlets does not usually clear until early August.

Figures 2.20 through 2.31 show the mean evolution of the ice cover. In winter there are three broad types of sea ice present in the region: consolidated pack ice, unconsolidated pack ice and shore-fast ice.

Consolidated pack ice is present west of the ice arch which forms across Lancaster Sound at longitudes between 81° W and 96° W but usually near

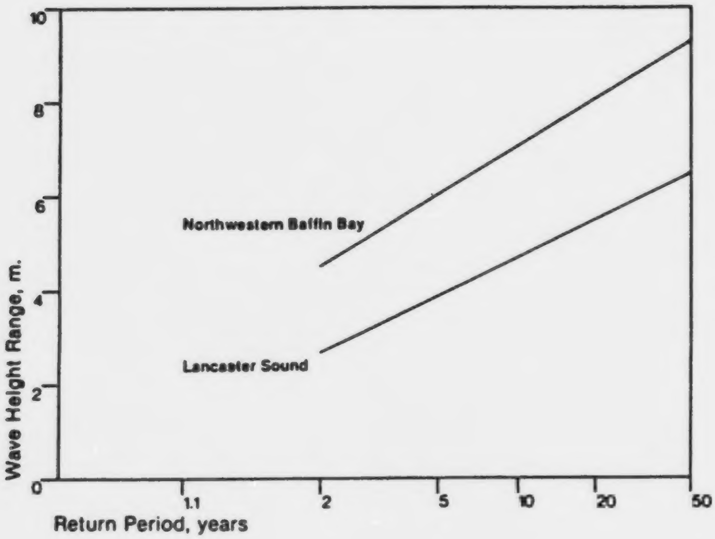


**Figure 2.19** Estimated wave return period for northeastern Baffin Bay and Lancaster Sound (from Maxwell, 1980).

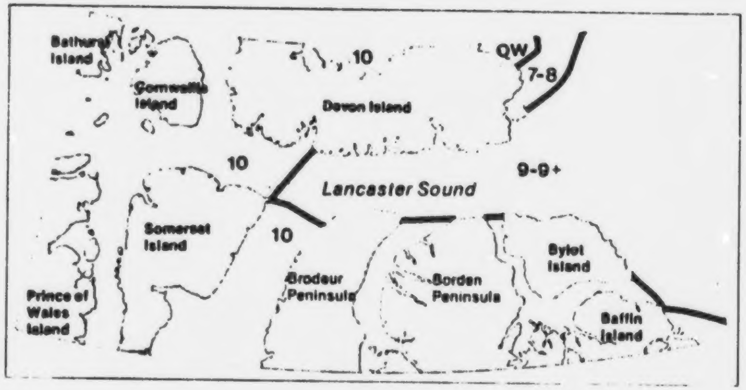

Bathurst Island
Cornwallis Island
10
Devon Island
OW
7-8
10
9-9+
Lancaster Sound
Somerset Island
10
Brodeur Peninsula
Borden Peninsula
Bylot Island
Prince of Wales Island
Baffin Island

**Figure 2.20** Median total ice May 28 (from Sowden, 1980).

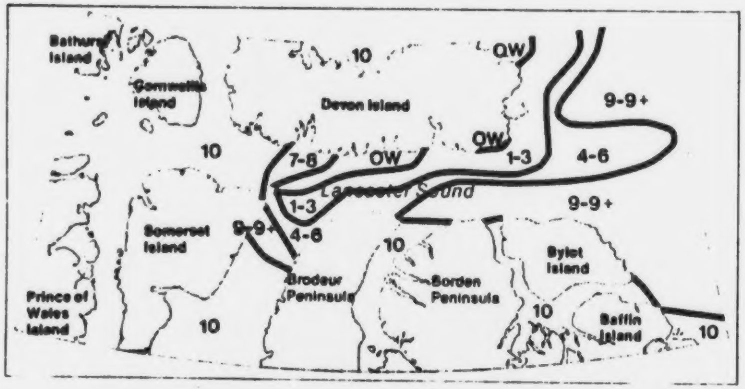

Bathurst Island
Cornwallis Island
10
OW
Devon Island
9-9+
10
OW
7-8
OW
1-3
4-6
Lancaster Sound
1-3
9-9+
Somerset Island
9-9+
4-6
10
Borden Peninsula
Bylot Island
Brodeur Peninsula
Prince of Wales Island
10
10
Baffin Island
10

**Figure 2.21** Median total ice June 11 (from Sowden, 1980).

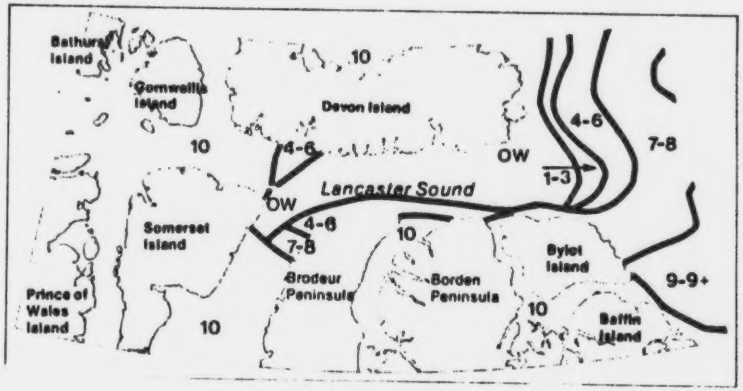

Bathurst Island
10
Cornwallis Island
Devon Island
4-6
10
4-6
OW
7-8
1-3
Lancaster Sound
OW
4-6
Somerset Island
7-8
10
Bylot Island
9-9+
Brodeur Peninsula
Borden Peninsula
Prince of Wales Island
10
10
Baffin Island

**Figure 2.22** Median total ice June 25 (from Sowden, 1980).

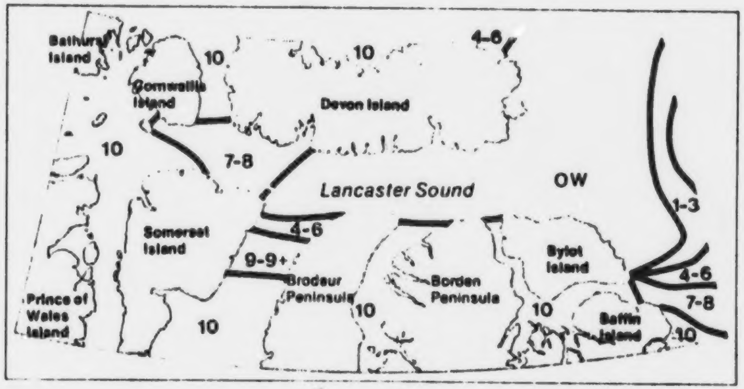

Bathurst Island
10
10
4-6
Cornwallis Island
Devon Island
10
7-8
Lancaster Sound
OW
1-3
Somerset Island
4-6
9-9+
Bylot Island
4-6
Brodeur Peninsula
Borden Peninsula
7-8
Prince of Wales Island
10
10
10
Baffin Island
10

**Figure 2.23** Median total ice July 9 (from Sowden, 1980).

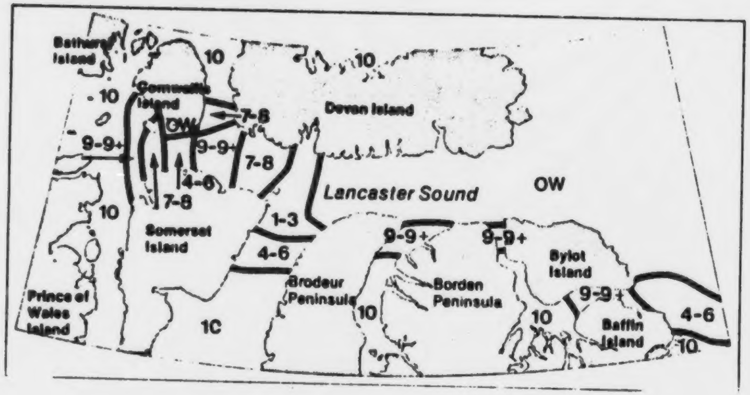

Bathurst Island
Cornwallis Island
Devon Island
Lancaster Sound
OW
Somerset Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island
Prince of Wales Island
10
9-9+
7-8
4-6
1-3
1C

**Figure 2.24** Median total ice July 23 (from Sowden, 1980).

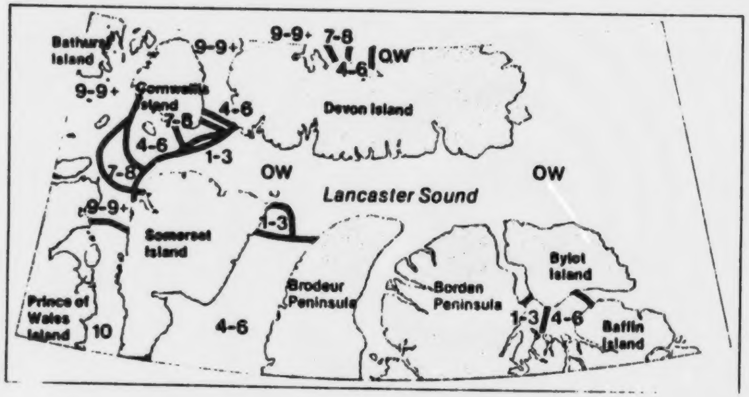

Bathurst Island
Cornwallis Island
Devon Island
Lancaster Sound
OW
Somerset Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island
Prince of Wales Island
9-9+
7-8
4-6
1-3
10

**Figure 2.25** Median total ice August 6 (from Sowden, 1980).

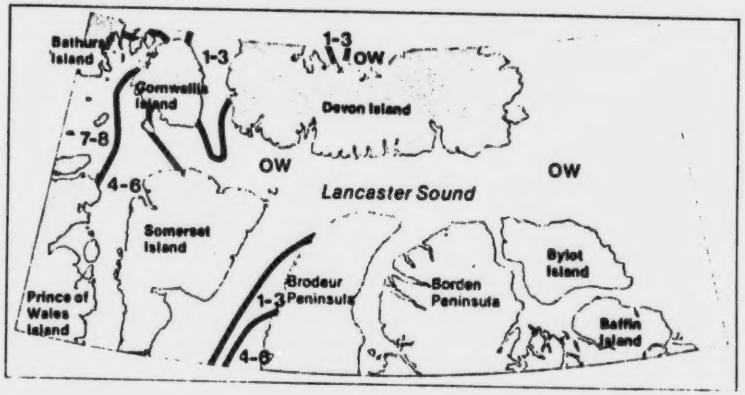

Bathurst Island
Cornwallis Island
Devon Island
Lancaster Sound
OW
Somerset Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island
Prince of Wales Island
1-3
7-8
4-6

**Figure 2.26** Median total ice August 20 (from Sowden, 1980).

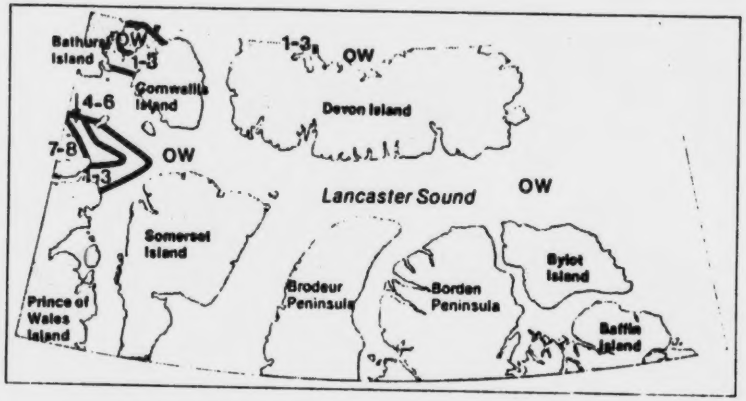

Bathurst Island
Cornwallis Island
Devon Island
Lancaster Sound
OW
Somerset Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island
Prince of Wales Island
1-3
4-6
7-8

**Figure 2.27** Median total ice September 3 (from Sowden, 1980).

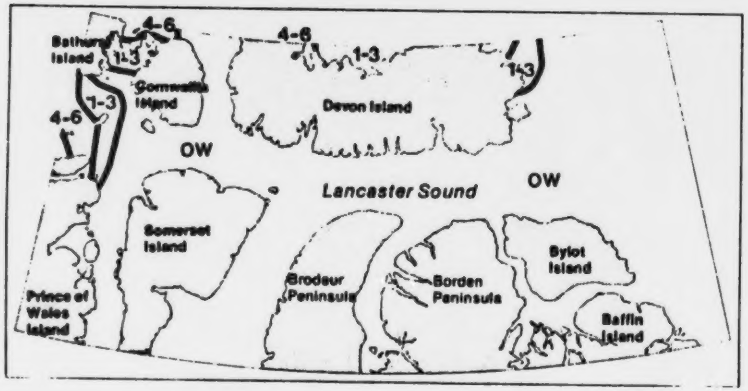

Bathurst Island
4-6
1-3
4-6
1-3
1-3
Cornwallis Island
4-6
1-3
Devon Island
OW
Lancaster Sound
OW
Somerset Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Prince of Wales Island
Baffin Island

**Figure 2.28** Median total ice September 17 (from Sowden, 1980).

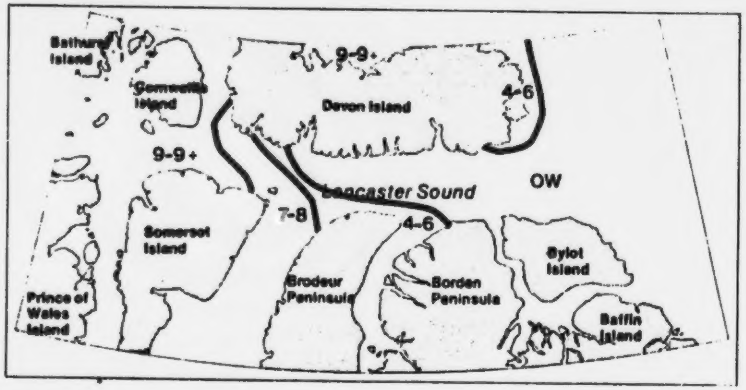

Bathurst Island
Cornwallis Island
9-9+
Devon Island
4-6
9-9+
Lancaster Sound
OW
7-8
4-6
Somerset Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Prince of Wales Island
Baffin Island

**Figure 2.29** Median total ice October 1 (from Sowden, 1980).

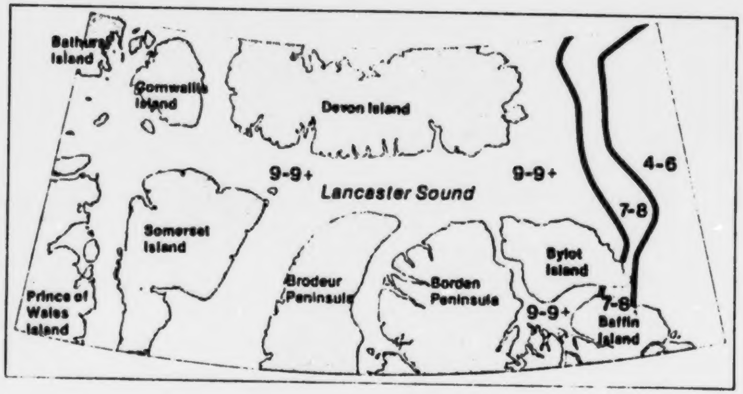

Bathurst Island
Cornwallis Island
Devon Island
9-9+
9-9+
4-6
Lancaster Sound
7-8
Somerset Island
Bylot Island
Brodeur Peninsula
Borden Peninsula
9-9+
7-8
Prince of Wales Island
Baffin Island

**Figure 2.30** Median total ice October 15 (from Sowden, 1980).

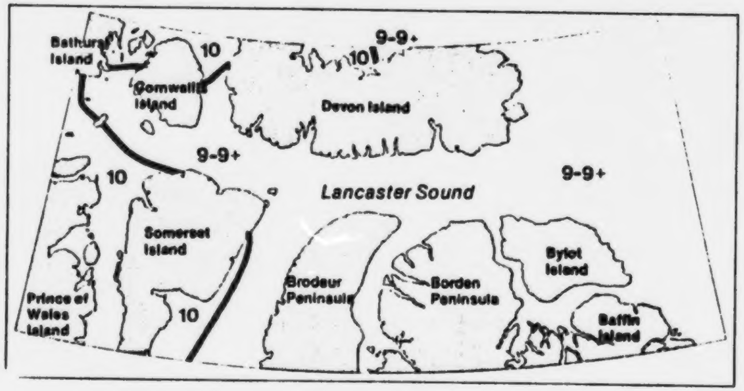

Bathurst Island
10
9-9+
10
Cornwallis Island
Devon Island
9-9+
10
9-9+
Lancaster Sound
Somerset Island
Bylot Island
Brodeur Peninsula
Borden Peninsula
10
Prince of Wales Island
Baffin Island

**Figure 2.31** Median total ice October 29 (from Sowden, 1980.)

90° W - west of the study region. Unconsolidated pack ice is found east of the ice arch and into Baffin Bay.

Shore-fast ice is present in Navy Board Inlet, Eclipse Sound and Pond Inlet, in the numerous bays along the coast and the very near shore in Lancaster Sound. During late winter and spring recurring voids or fractures in the sea ice appear in Navy Board and Pond Inlets. These features are well known to the local Inuit. The cracks apparently recur predictably in time and space. Such recurring open-water areas are, of course, extremely important to local hunters.

Winds and currents rather than air temperature determine the distribution of the three sea ice species. Thus the sheltered channels permit land-fast ice formation, while the ice arch occurs where the consolidated pack can just withstand the stresses imposed by wind and currents.

There is very little multi-year ice in the region (less than 1/10). What little of it is found has been advected southward and eastward from the Sverdrup Basin and Viscount Melville Sound and is generally concentrated in the southern portion of Lancaster Sound. The thickest multi-year ice flow measured in Lancaster Sound was 3.4 m thick (Pelletier, 1980).

Icebergs enter the region advected by the intrusive flow of the Baffin Current. They move along the southern shore of Devon Island at drift rates up to 50 km per day (Figure 2.32). The majority of these bergs turn south before achieving 84° W and exit Lancaster Sound along the north shore of Bylot Island. They generally follow the coastline south offshore Bylot and Baffin Islands. Relatively few bergs enter Navy Board Inlet or Pond Inlet.

Perhaps the most distinctive ice feature in eastern Lancaster Sound is the ice arch or curved ice edge which forms across the sound, anywhere between 81° W and 96° W longitude (Figure 2.33). It is concave toward the east, this form indicating that the arch resists a load imposed from the west.

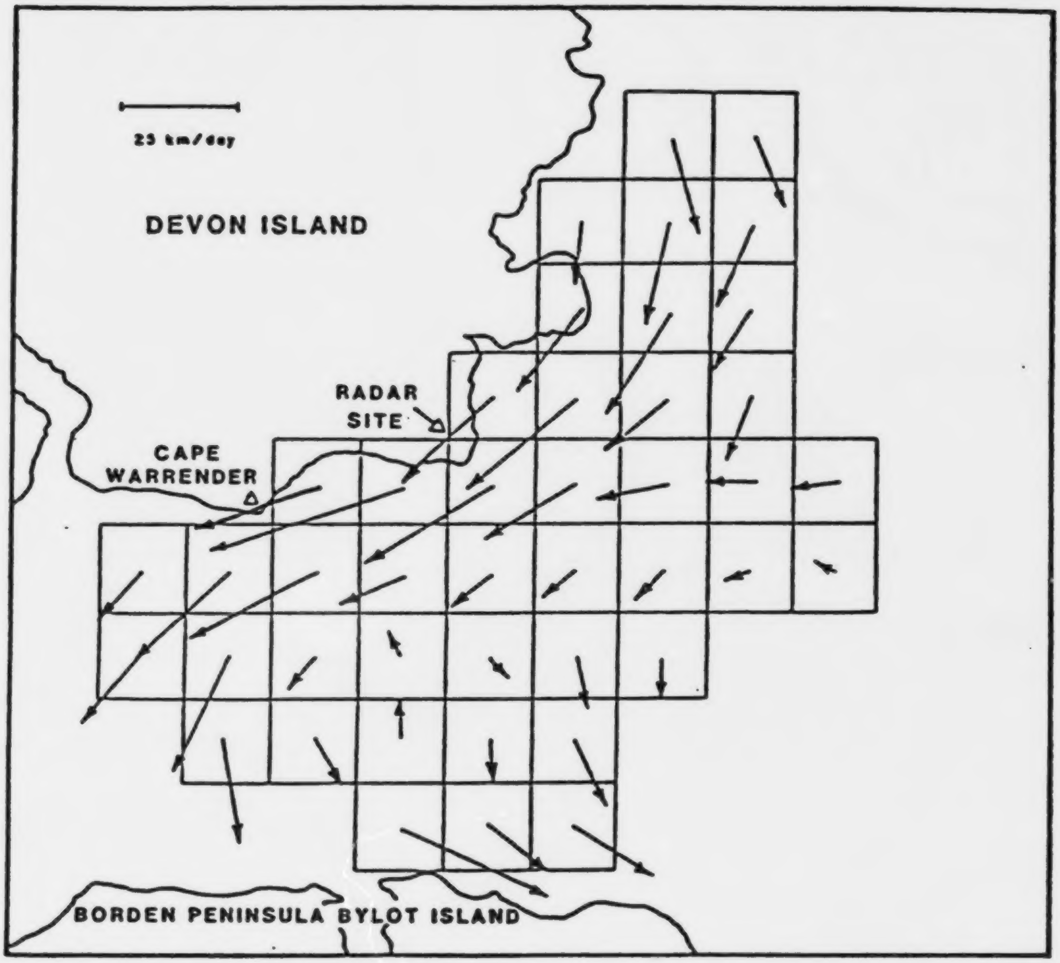

25 km/day
DEVON ISLAND
RADAR SITE
CAPE WARRENDER
BORDEN PENINSULA
BYLOT ISLAND

**Figure 2.32** Average iceberg velocity vectors from 1978. Hope Mountain radar-tracked berg data (Marko, 1982).

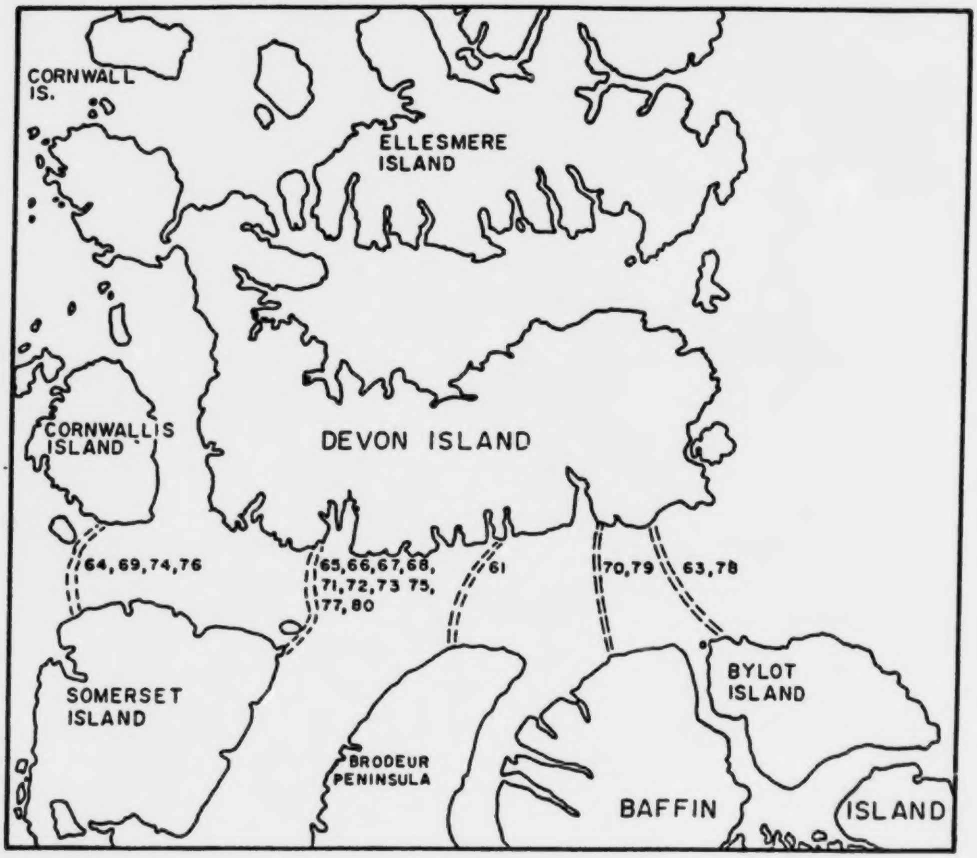

CORNWALL IS.
ELLESMERE ISLAND
CORNWALLIS ISLAND
DEVON ISLAND
64,69,74,76
65,66,67,68, 71,72,73 75, 77,80
61
70,79
63,78
SOMERSET ISLAND
BYLOT ISLAND
BRODEUR PENINSULA
BAFFIN
ISLAND

**Figure 2.33** Approximate annual positions of the stable winter landfast ice edge, 1961-1980 (Marko, 1982).

Whereas consolidated pack ice is found west of the arch, to the east of the arch nearly open-water conditions can prevail. The formation of the arch is probably due to successive failures of the ice sheet caused by strong winds driving the ice. As the ice edge retreats it tends to form its most stable configuration - that of a nearly parabolic arch. Since ice is advected eastward in Lancaster Sound there exists an unstable equilibrium of ice arch decay and replenishment.

The formation of recurring polynas or leads in the ice regime of Lancaster Sound and Baffin Bay is also an important feature. Landfast ice forms in Lancaster Sound by late September or early October. By mid to late October the sound becomes completely ice-covered, although still unconsolidated. A system of open shoreleads and cracks usually develops between mid November and mid December, remaining in some form through the winter until break-up (Smith and Rigby, 1981). The exact location and pattern of the leads changes periodically under the influence of currents and winds (Figure 2.34. The waters surrounding Bylot Island are also usually frozen by the end of October, accompanying the freeze-up of Baffin Bay. A lead develops between the shore fast ice around Bylot Island and the drift ice in Baffin Bay. The lead appears to open and close in response to the winds and general motion of the pack ice in Baffin Bay (Smith and Rigby, 1981), see Figure 2.35.

The regions in proximity to the ice edge and leads are important to marine life. Marine mammals frequently congregate in these areas, possibly because of the availability of air for breathing. Ice edges also provide a partial mechanical isolation of the ocean from the effects of wind. A stress divergence is located along the ice edge and, depending upon the wind direction, may cause upwelling. Upwelling in turn, can supply nutrients to the near-surface photic zone and enhance primary productivity. The presence of an ice edge therefore can promote upwelling; conversely upwelling and intense vertical mixing can maintain permanent open water areas year-round. These areas are polynyas (or polynii). Informal

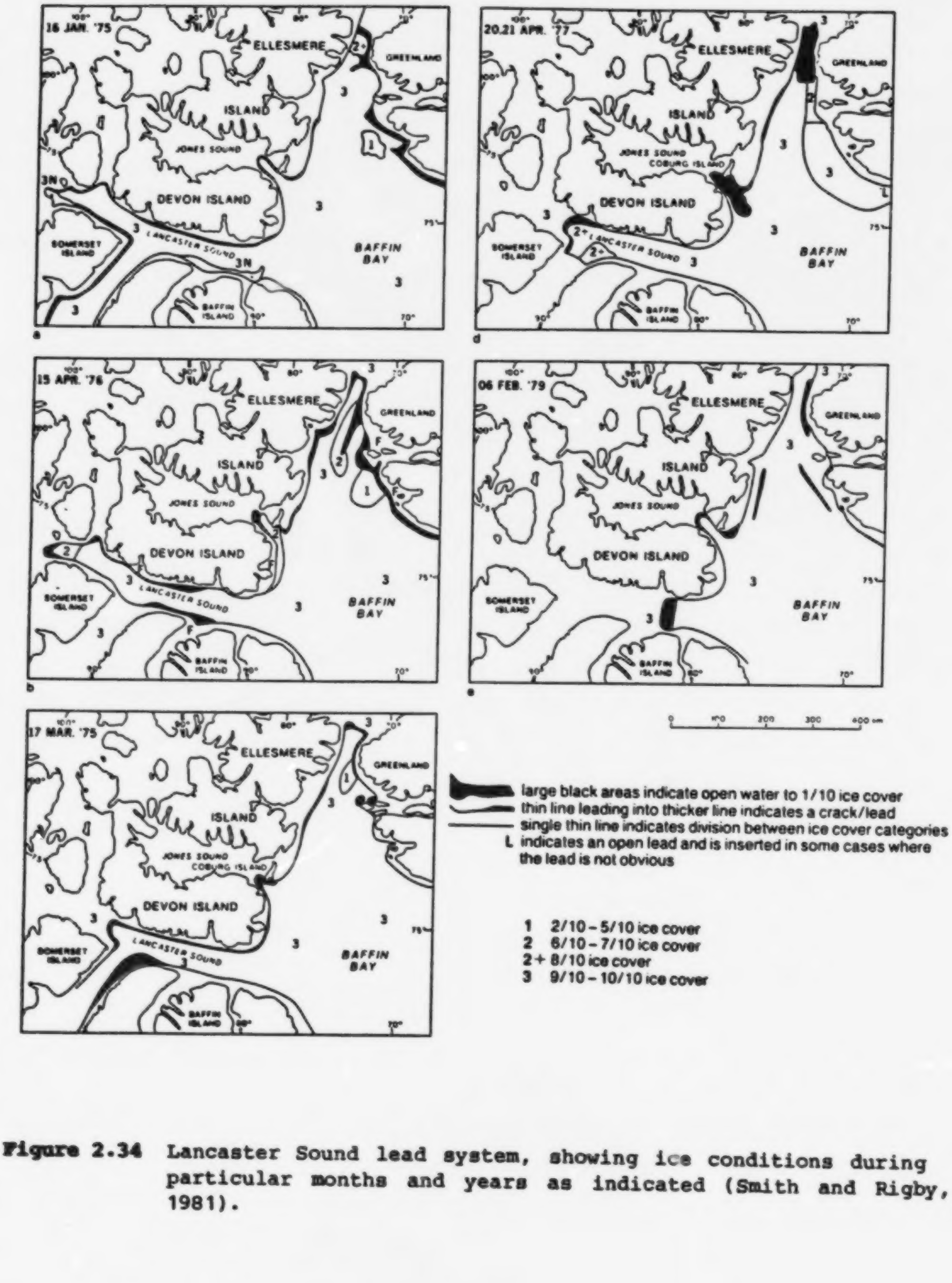

16 JAN. '75
20,21 APR. '77
15 APR. '76
06 FEB. '79
17 MAR. '75
ELLESMERE
ISLAND
GREENLAND
JONES SOUND
COBURG ISLAND
DEVON ISLAND
SOMERSET ISLAND
LANCASTER SOUND
BAFFIN BAY
BAFFIN ISLAND
a
b
c
d
e
0 100 200 300 400 km
large black areas indicate open water to 1/10 ice cover
thin line leading into thicker line indicates a crack/lead
single thin line indicates division between ice cover categories
L indicates an open lead and is inserted in some cases where the lead is not obvious
1 2/10 - 5/10 ice cover
2 6/10 - 7/10 ice cover
2+ 8/10 ice cover
3 9/10 - 10/10 ice cover

**Figure 2.34** Lancaster Sound lead system, showing ice conditions during particular months and years as indicated (Smith and Rigby, 1981).

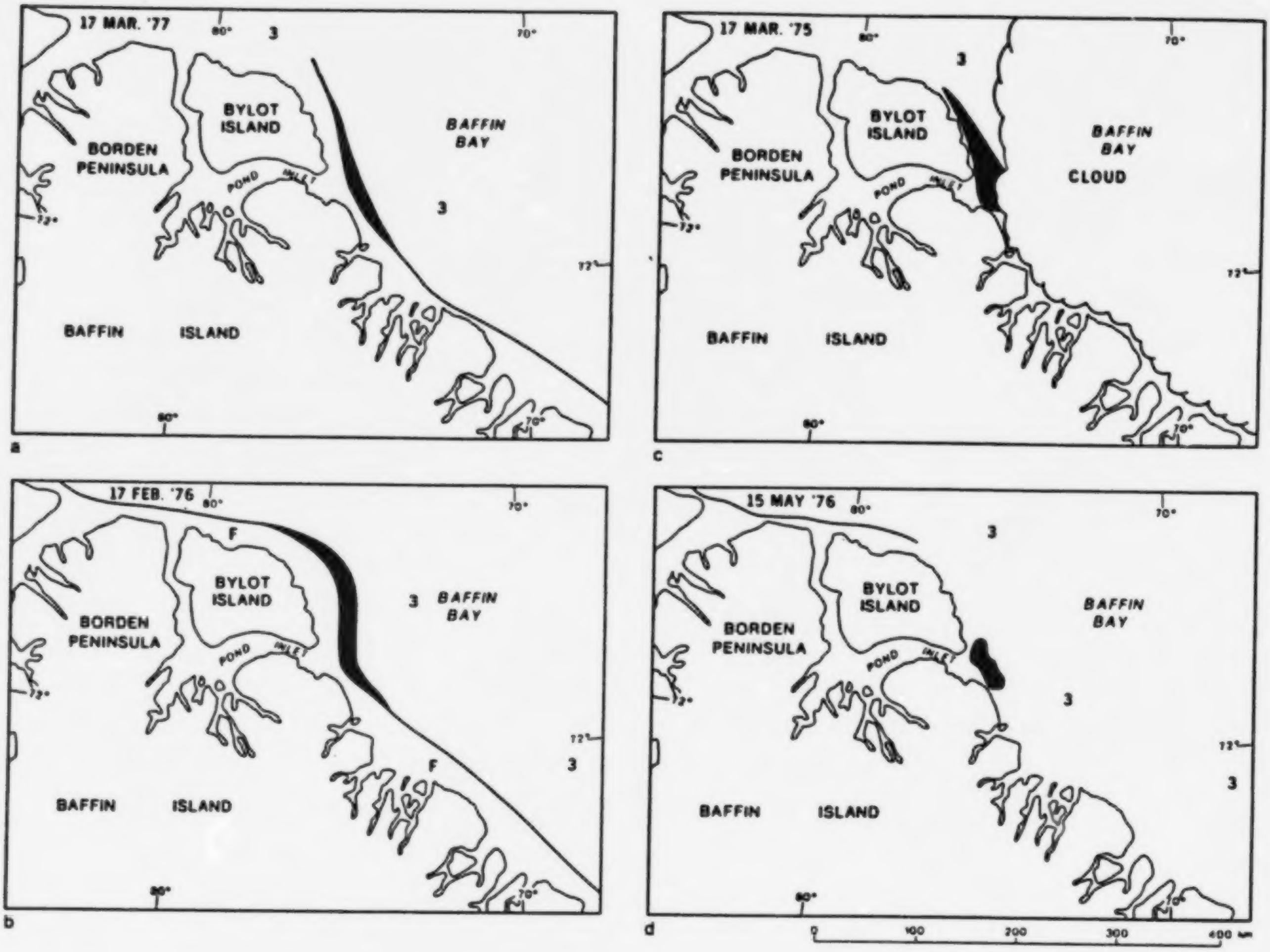

17 MAR. '77
80°
70°
3
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
POND INLET
3
72°
72°
BAFFIN ISLAND
80°
70°
a
17 MAR. '75
80°
70°
3
BYLOT ISLAND
BAFFIN BAY
CLOUD
BORDEN PENINSULA
POND INLET
72°
72°
BAFFIN ISLAND
80°
70°
c
17 FEB. '76
80°
70°
F
BYLOT ISLAND
3
BAFFIN BAY
BORDEN PENINSULA
POND INLET
72°
72°
F
3
BAFFIN ISLAND
80°
70°
b
15 MAY '76
80°
70°
3
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
POND INLET
3
72°
72°
3
BAFFIN ISLAND
80°
70°
d
0
100
200
300
400 km

Figure 2.35 Bylot Island lead system, showing ice conditions during particular months and years as indicated (Smith and Rigby, 1981).

discussions with residents of Pond Inlet and Arctic Bay indicate that seasonal polynyas recur at specific locations each year. These are probably associated with strong tidal currents.

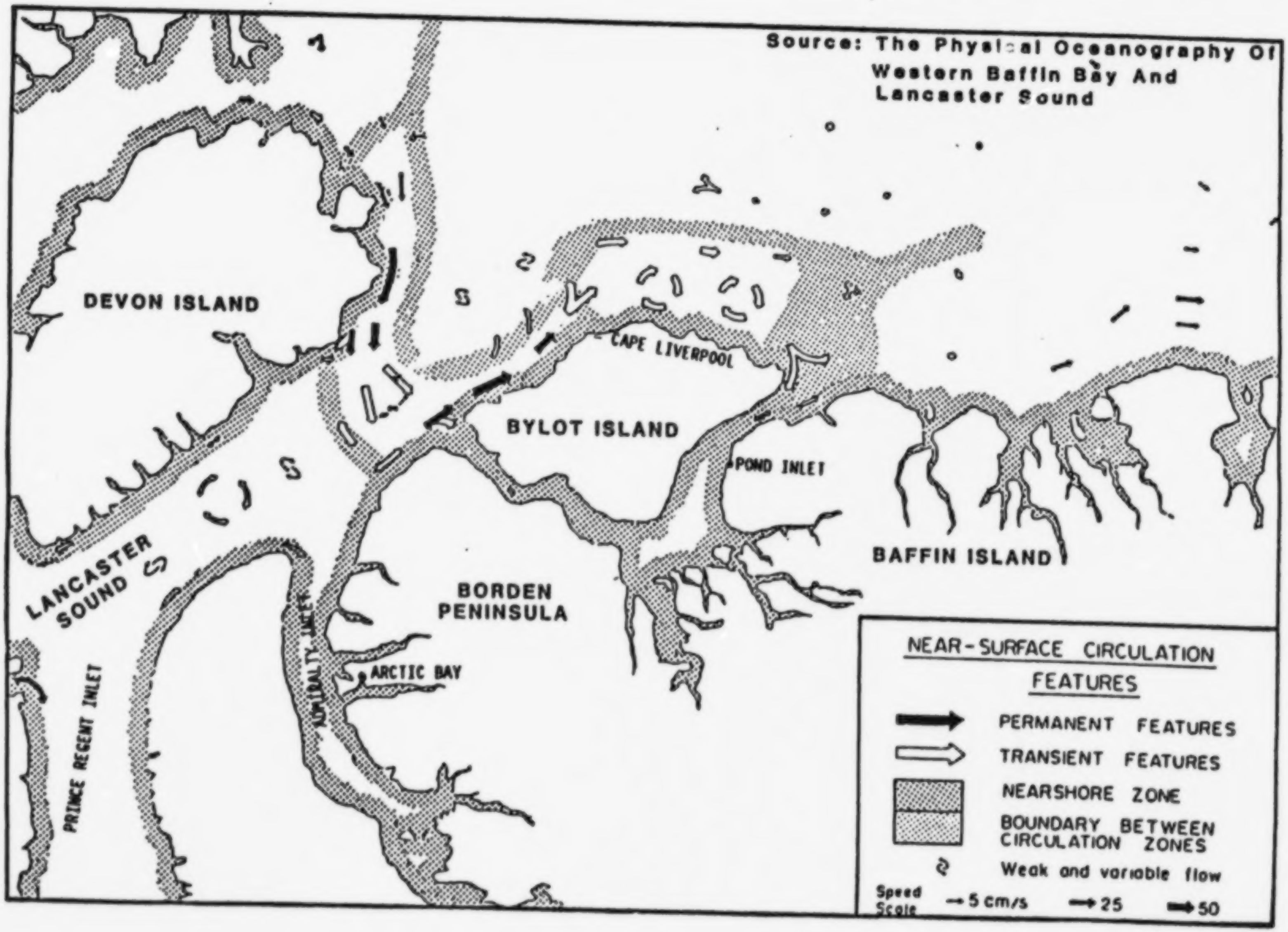
### 2.2.3 Currents

The circulation in the region is dominated by the westward intrusion of the south-flowing Baffin Current into Lancaster Sound. The current flows southward along the east coast of Ellesmere Island and Devon Island, then westward along the south coast of Devon Island. It then flows southward across the Sound at distances of 35 to 75 km from the eastern boundary and exits again into Baffin Bay along the northwest coast of Bylot Island, with a minor outflow south through Navy Board Inlet (Figure 2.36). The velocities associated with the intrusive current are generally strong near the surface, decreasing with depth; typical near-surface (4 to 11 m) velocities are 75 cm/s (approximately 1.5 knots) decreasing to 50 cm/s (approximately 1 knot) at 40 m depth, 25 cm/s (approximately 0.5 knots) at 250 m depth and 14 cm/s (approximately 0.25 knots) at 500 m depth. Often the current extends to the bottom of eastern Lancaster Sound, which is less than 800 m in depth (Figure 2.37).

The intrusive currents are associated with oceanic fronts as observed in water property cross-sections. They provide a means for enhanced vertical motions due to reduced stratification. Increased upward movement of nutrients may be characteristic of the fronts, resulting in enhanced biological productivity (Fissel et al., 1981). It is this established flow which determines the trajectories of icebergs and the pattern of break-up.

In addition to the mean flow of the intruding Baffin Current, locally wind driven currents are present and dominate the surface flow in areas with weak mean currents.

The year-to-year variability of currents in Lancaster Sound is weak. Although current speeds vary by nearly a factor of two, little year-to-year



Source: The Physical Oceanography Of Western Baffin Bay And Lancaster Sound

DEVON ISLAND
BYLOT ISLAND
CAPE LIVERPOOL
POND INLET
BAFFIN ISLAND
BORDEN PENINSULA
ARCTIC BAY
ADMIRALTY INLET
LANCASTER SOUND
PRINCE REGENT INLET
NEAR-SURFACE CIRCULATION FEATURES
PERMANENT FEATURES
TRANSIENT FEATURES
NEARSHORE ZONE
BOUNDARY BETWEEN CIRCULATION ZONES
Weak and variable flow
Speed Scale
→5 cm/s
→25
→50

Figure 2.36 Lancaster Sound - near-surface circulation features (CMO, 1983).

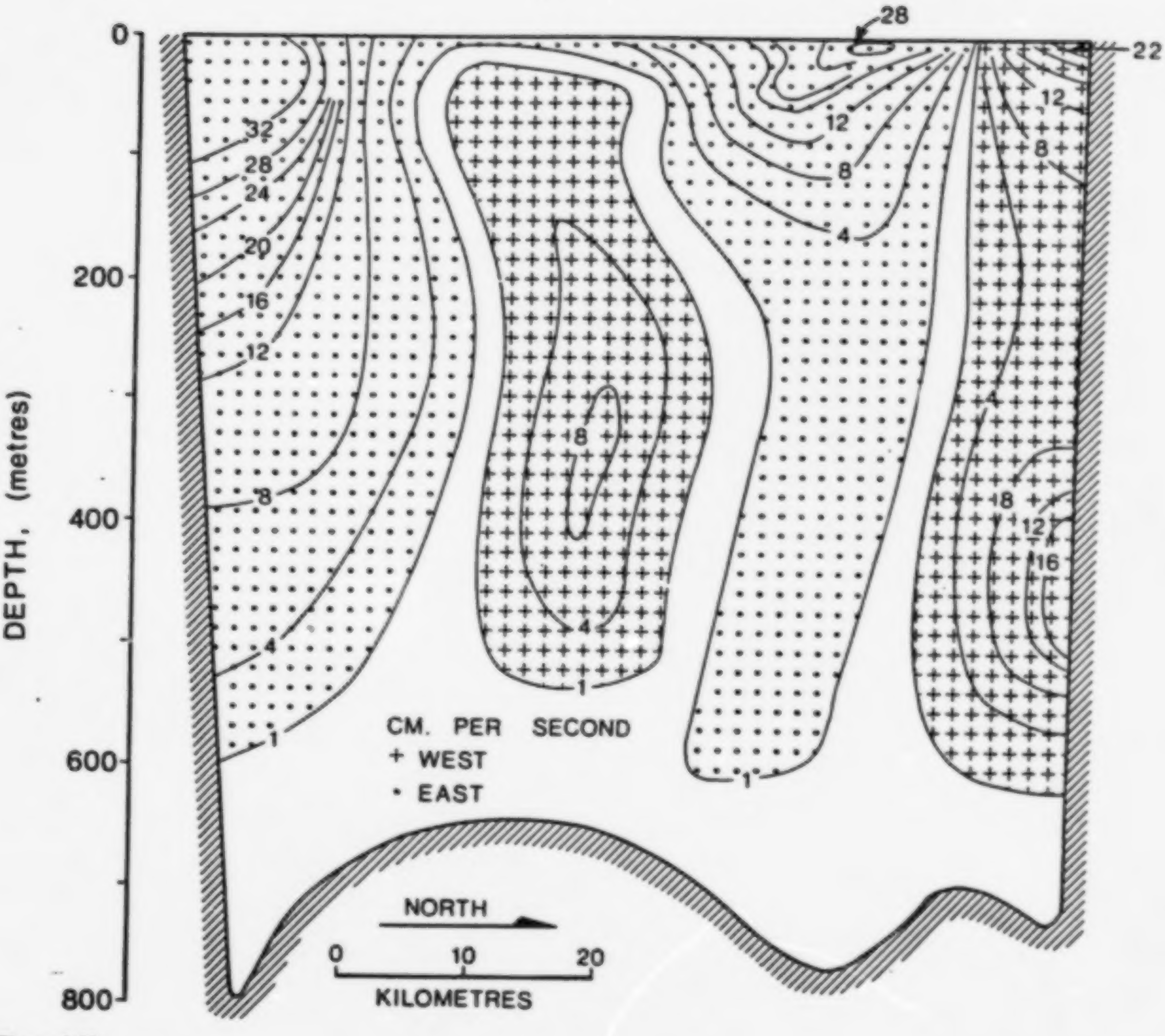


Figure 4.29

**Figure 2.37** Calculated current speeds (50 cm/s is approximately equivalent to 1 knot) in a cross-section of Lancaster Sound, in September at 82°W (Milne and Smiley, 1978).

change is found in the overall summer flow pattern (E.I.S., 1983). There do however, appear to be two general flow patterns between which the currents vary during a given year (Fissel et al., 1982). These are shown in Figure 2.38. The first pattern is characterized by the current intruding westward to Cape Warrender then recurving eastward and leaving Lancaster Sound north of Bylot Island. The second pattern has the current impinging on the Borden Peninsula before spreading broadly to the east and forming a tightly recurving gyre north of Admiralty Inlet as well.

Tidal and inertial currents have been measured in the region (Fissel, 1982). The tidal constituent amplitudes are less than 15 cm/s (approximately 0.3 knots). However, it is the sum of the amplitudes of the tidal constituents which comprises the tidal stream. Presumably, therefore, tidal currents can approach 40 to 50 cm/s (approximately 1 knot) at spring tide. The inertial currents are strongest near the surface and speeds of up to 35 cm/s (approximately 0.7 knots) were measured.

In the waterway bounding the west and south coasts of Bylot Island, the net flow is southward through Navy Board Inlet and then eastward through Pond Inlet into Baffin Bay. Typical near surface flow speeds are 20 to 30 cm/s (approximately 0.4 to 0.6 knots). Data in Eclipse Sound are limited but there is an indication of westerly flow on the north side and easterly flow on the south, with north-south flows evident at both ends of the Sound. In Pond Inlet an intrusive circulation from Baffin Bay is evident with the greatest penetration being about 36 km. Inflow is westerly on the north side, with the outflow along the southern side and typical flow speeds of 12-28 cm/s (approximately 0.25 to 0.5 knots).

The large amounts of freshwater which enter Eclipse Sound from the melting of sea-ice and run-off may drive an estuarine circulation. Given the observed tendency of water movement to the south and then east through the Navy Board Inlet, Eclipse Sound and Pond Inlet waterway, the fresh water outflow from Eclipse Sound appears most likely to exit the region through Pond Inlet.

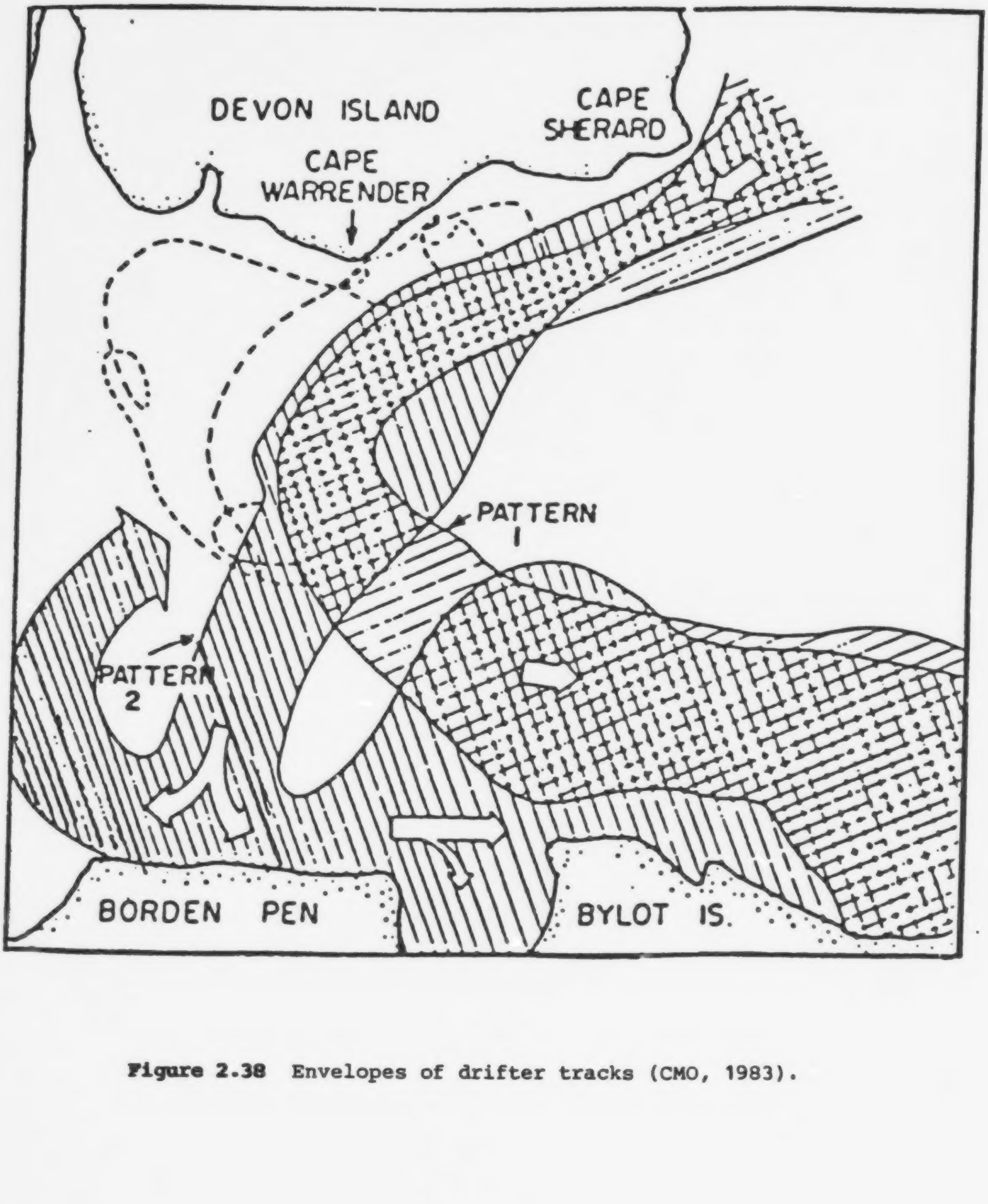

DEVON ISLAND
CAPE SHERARD
CAPE WARRENDER
PATTERN 1
PATTERN 2
BORDEN PEN
BYLOT IS.

**Figure 2.38** Envelopes of drifter tracks (CMO, 1983).

### 2.2.4 Water Properties, Distribution of Temperature and Salinity With Depth

The waters of western Baffin Bay and Lancaster Sound can be divided into three vertical layers (Muench, 1971):

(a) Arctic Water, defined by low temperatures (0°C to -1.8°C) and low salinities (31°/oo to about 34°/oo). This generally extends to depths of 200 to 300 m in Baffin Bay and Lancaster Sound;

(b) Atlantic Water, defined by warmer temperatures (0°C to 2°C) and higher salinities (34.2°/oo to 34.5°/oo). This generally extends from the bottom of the Arctic Water layer to depths of 600-700 m in Lancaster Sound and 1200-1300 m in northern Baffin Bay;

(c) Deep Water, defined by low temperatures (0°C to 0.4°C) and nearly uniform salinities (34.48°/oo). This layer extends from the bottom of the Atlantic Water in Baffin Bay to the seabed. Since it is found below 600 m depth, it is confined to the very eastern deep water region of Lancaster Sound.

Based upon more recent work (Fissel et al., 1981) further details of the structure of the upper water column have been elaborated. Their findings from surveys in 1978 and 1979 are summarized below.

The upper zone of the Arctic Water layer is the portion of the water column extending from the surface to the limit of depths which are directly subject to large spatial and temporal variations due to the effect of surface processes such as solar heating, wind mixing and ice melt. The result of these modification processes is the production of a highly variable surface layer overlying the uniformly cold bulk of the Arctic Water. The range of observed temperatures and salinities is considerably enhanced in the upper layer. From the 1978 and 1979 CTD measurements in the upper zone, the range of observed temperatures was -1.8°C to 3.0°C or greater, while salinities ranging from 20.0°/oo to 32.5°/oo were recorded.

The depth of the uniform wind-mixed portion of the upper zone is variable, ranging from 0 m in the case of a pycnocline extending to the surface, to as much as 80 m. The mean depth was 13.5 m. In offshore areas, where the upper zone is less subject to the advective processes associated with strong coastal currents, the upper zone usually preserves a well-mixed character, and appears to deepen throughout the open water season under wind influence. Although wide variations are observed in surface layer temperature, they have little effect on the density stratification, which is primarily controlled by the salinity, or fresher water from melting ice. The density stratification in the upper layer is not readily altered once mixing has been achieved.

The transition zone between the cold Arctic water layer and the warmer, more saline Atlantic Water layer is the site of a great deal of interleaving between the two water masses. This structure consists of numerous sub-layers of relatively uniform temperature with large vertical temperature gradients occurring at sub-layer boundaries. The thickness of the sub-layers typically ranges from 6 to 30 m and temperature differences between sub-layers are as large as 0.5°C. Temperature interleavings were not present at all stations and did not show any discernible spatial pattern beyond a general tendency to follow the distribution of Atlantic Water.

Typical temperature and salinity cross-sections from Bylot Island northeastward toward Greenland are shown in Figures 2.39 and 2.40. A temperature-salinity cross-section along the axis of Lancaster Sound is shown in Figure 2.41.

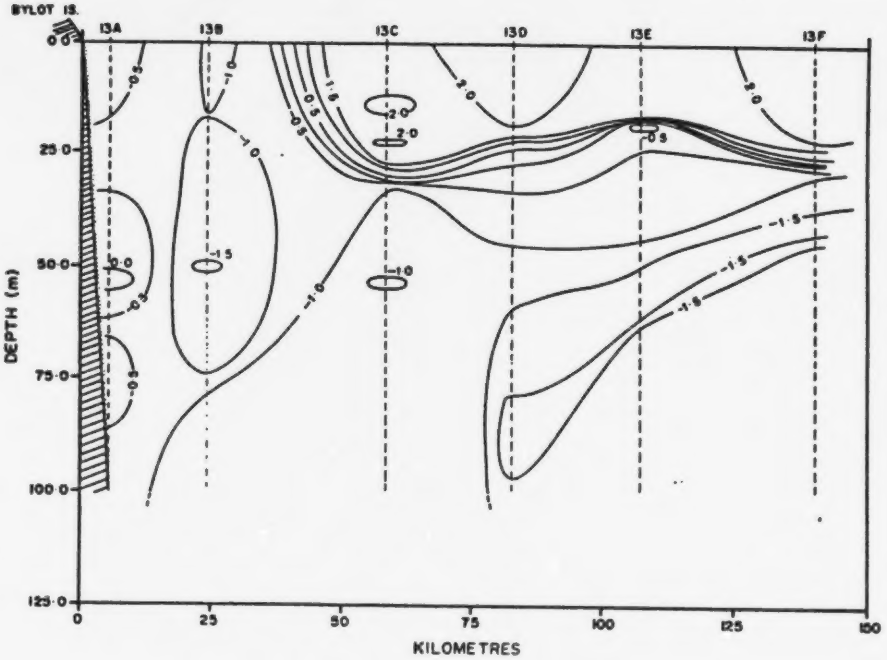


**Figure 2.39** Temperature, upper 100 meters, northeast from Bylot Island, August 25-26, 1979 (Fissel, et al, 1981).

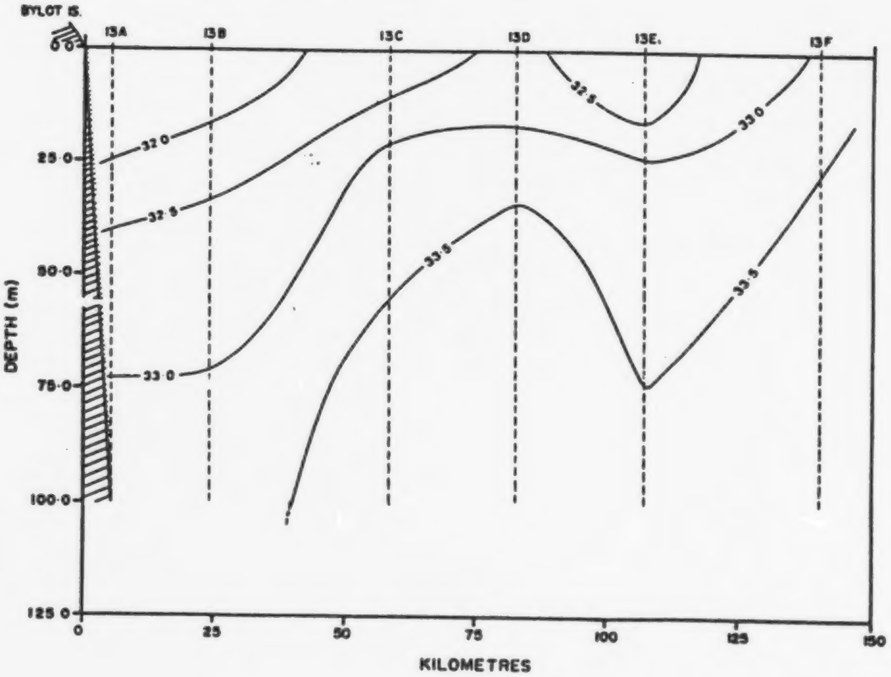


**Figure 2.40** Salinity, upper 100 meters, northeast from Bylot Island, August 25-26, 1979 (Fissel, et al, 1981).

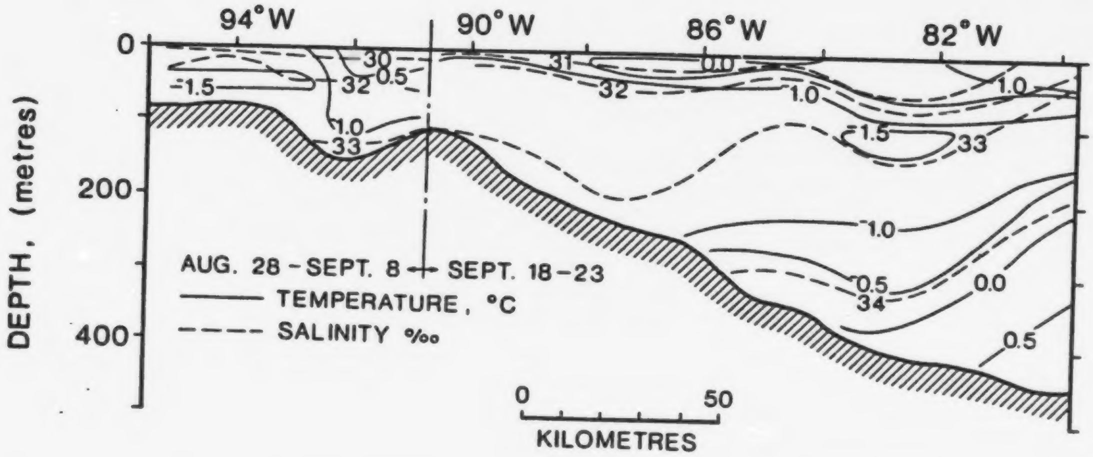


Figure 2.41 Temperature and salinity along the longitudinal axis of Lancaster Sound (Milne and Smiley, 1978).

### 2.2.5 Tides

The mean tidal range in the region is about 2 m. The maximum range of 2.9 m occurs at Dundas Harbour (C.H.S., 1984). The tides are predominantly semi-diurnal in character with small or negligible differences in the heights of the two daily high and low waters. Detailed tidal data are available in Greisman et al. (in press).

The magnitude of the tidal range largely determines the seaward extent and thickness of the bottom-fast ice foot which forms along the shore. Ice will generally form to the bottom in the intertidal zone and to the 2 m isobath.

## 2.3 MARINE CLIMATE

### 2.3.1 Winds

The winds are locally steered by the regional topography, particularly at shore-based weather stations. In addition, the sheltered nature of certain sites (e.g., Pond Inlet and Arctic Bay) strongly affects wind speed.

These points are clearly demonstrated in Figures 2.42 and 2.43 which display wind roses at several locations. Topographic chanelling along the NW-SE axis is apparent at Dundas Harbour and the high frequency of calm conditions at Pond Inlet and Arctic Bay reflect their sheltered locations.

Wind speeds are available for the months of August and September from shipboard observations (Figure 2.44). These show that during the navigation season the most frequently occurring wind speeds are between 5 and 20 knots. Extreme wind statistics are available from the community weather stations and are presented in Figure 2.45. The estimated return periods of wind speeds for several durations are presented in Figure 2.46.

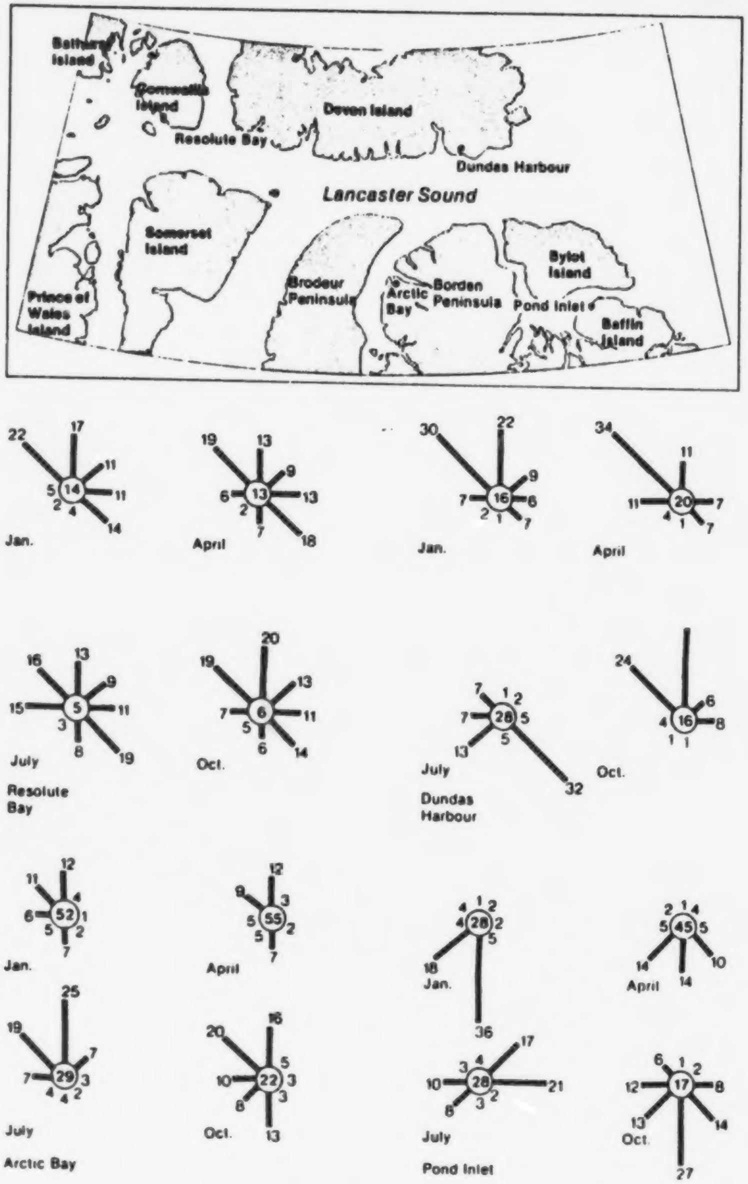


**Figure 2.42** Jan., April, July, Oct. Wind roses (from Maxwell, 1980).

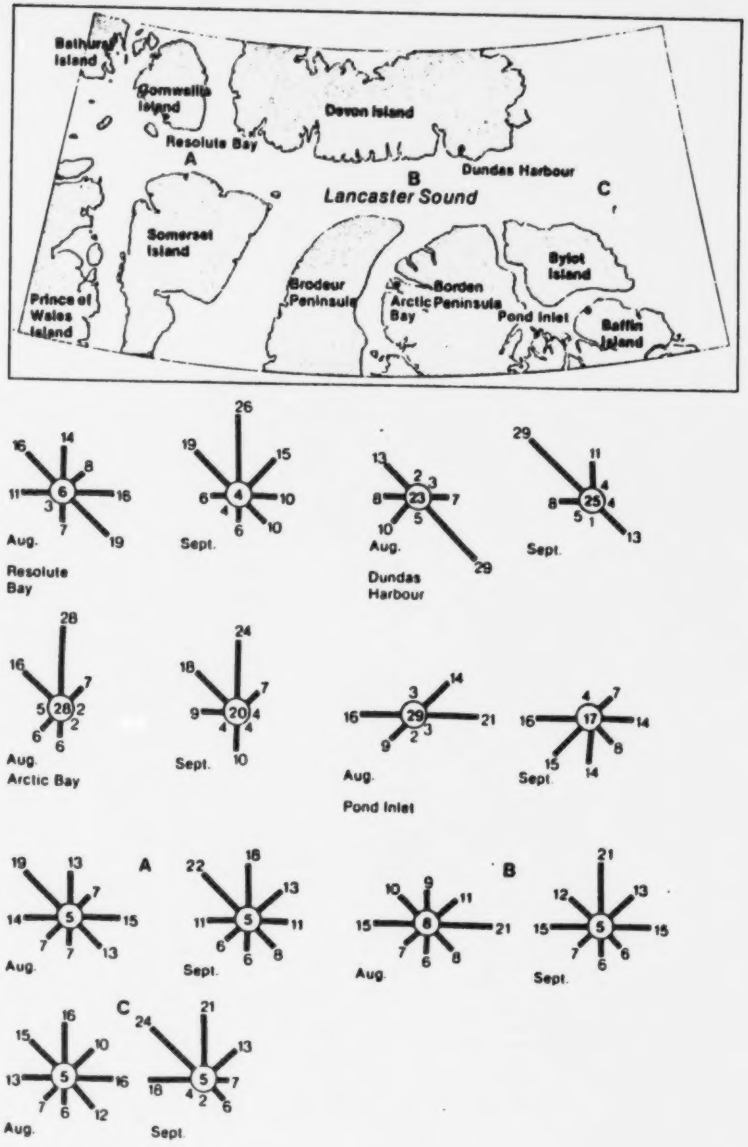


**Figure 2.43** August and Sept. wind roses (from Maxwell, 1980).

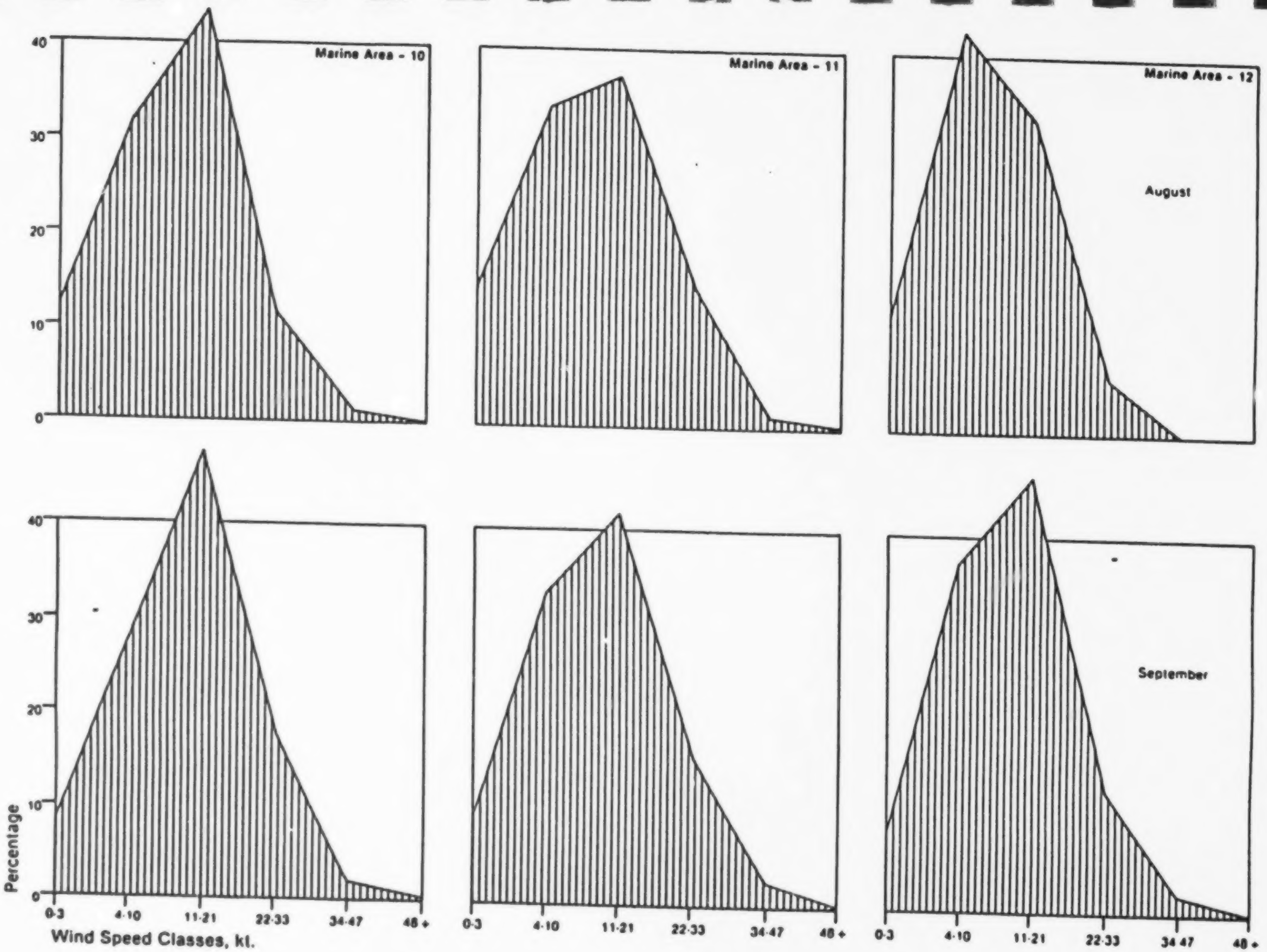
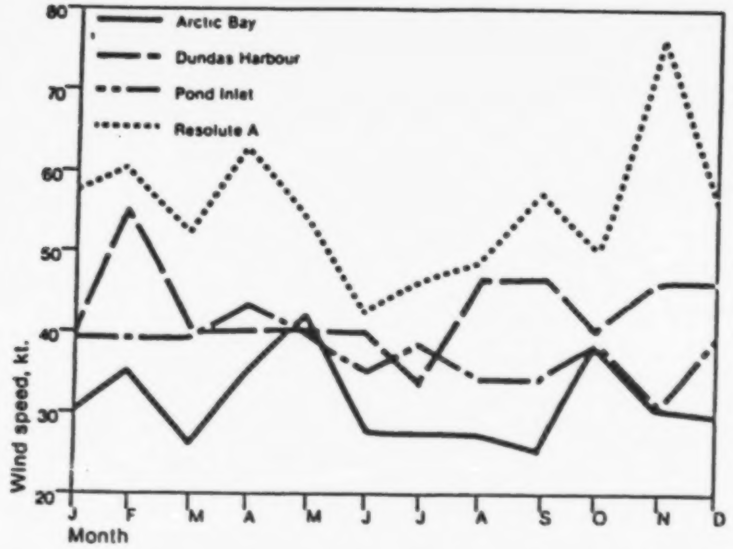


**Figure 2.44** Wind speed distributions in marine areas 10, 11 and 12 (see Figure 2.17) (from Maxwell, 1980).



**Figures 2.45** Observed monthly extreme hourly wind speeds (from Maxwell, 1980).

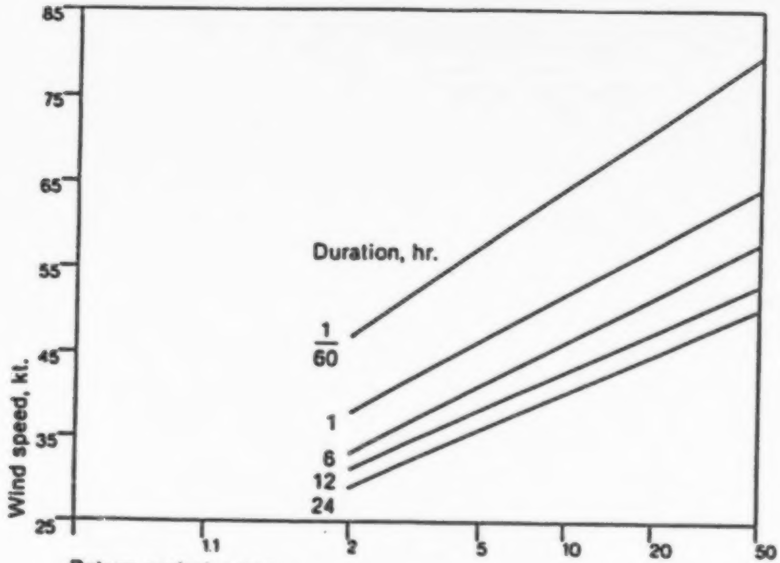


**Figure 2.46** Estimated return periods for wind speeds for the July-to-October period in Lancaster Sound (from Maxwell, 1980).

In general, the winds (and surface waves) in the region are weaker than those experienced in the Gulf of Alaska, off Newfoundland or in the Gulf of Mexico. Extreme wind speeds in Lancaster Sound are about two-thirds as great and extreme waves are about one-third as large as those in the other regions (Milne, 1978).

### 2.3.2 Temperature

Mean air temperatures are slightly moderated in the eastern part of the region due to its proximity to Baffin Bay. Figure 2.47 shows the mean daily isotherms for January, May, July and September. During the open water season the mean over-water temperatures lie in the 3°C to 4°C range with temperatures over land a few degrees warmer.

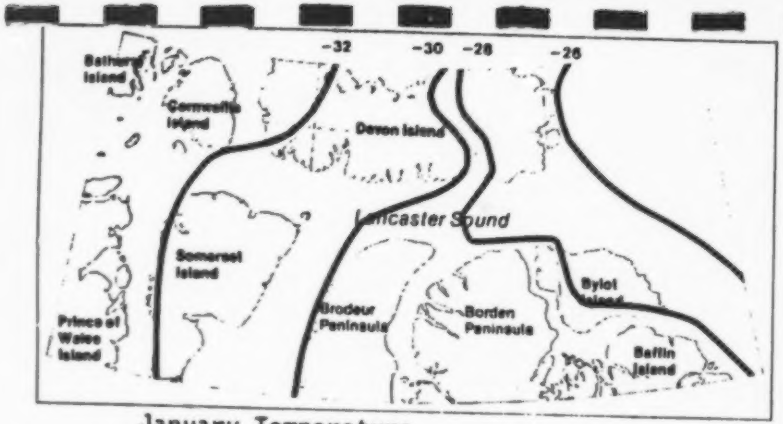
The extreme temperature values for four communities in and near the region are shown in Figure 2.48. Temperatures as low as -50°C and as high as +20°C have been recorded at Pond Inlet.

### 2.3.3 Precipitation

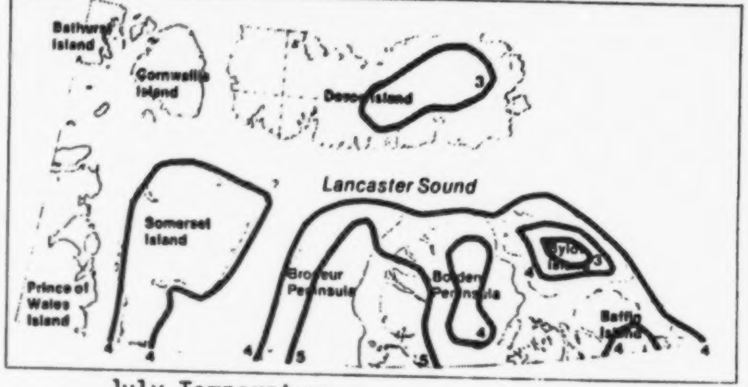
Patterns of mean annual rainfall, snowfall and precipitation for the region are shown in Figures 2.49 to 2.51. The largest source of moisture is the northward travelling low pressure systems originating in the Davis Strait region, but the Northwater is also a major source. Precipitation is greater at higher elevation on Devon, Baffin and Bylot Islands.

The coasts of north Baffin and Bylot Islands receive appreciable amounts of precipitation in the fall while Lancaster Sound is open and the prevailing winds are from the northern sector.

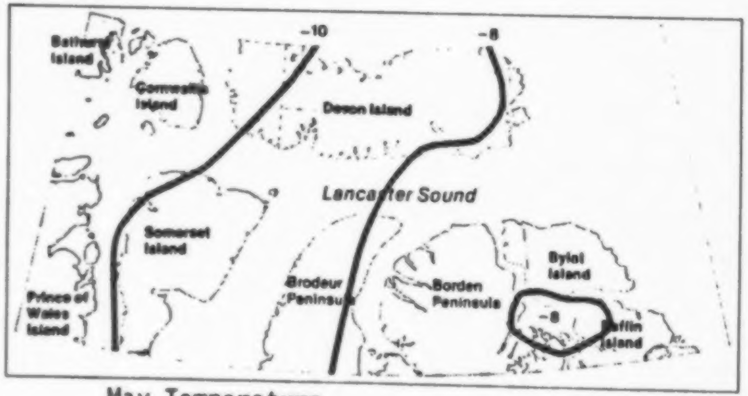
Figure 2.52 indicates the mean monthly rainfall and snowfall amounts at the coastal weather stations. July and August are the months of maximum rainfall, while October is the month of maximum snowfall.


-32
-30
-28
-26
Bathurst Island
Cornwallis Island
Devon Island
Lancaster Sound
Somerset Island
Prince of Wales Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island

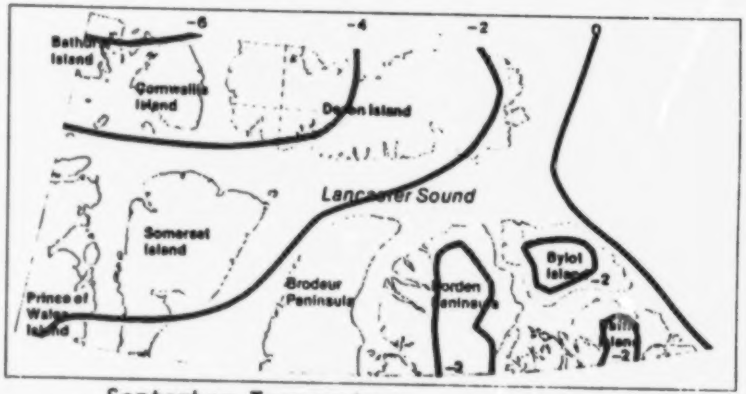
January Temperature


Bathurst Island
Cornwallis Island
Devon Island
3
Lancaster Sound
Somerset Island
Prince of Wales Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island
4
5

July Temperature


-10
-8
Bathurst Island
Cornwallis Island
Devon Island
Lancaster Sound
Somerset Island
Prince of Wales Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island

May Temperature


-6
-4
-2
0
Bathurst Island
Cornwallis Island
Devon Island
Lancaster Sound
Somerset Island
Prince of Wales Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island

September Temperature

**Figure 2.47** Mean air temperatures (°C) through the year (from Maxwell, 1980).

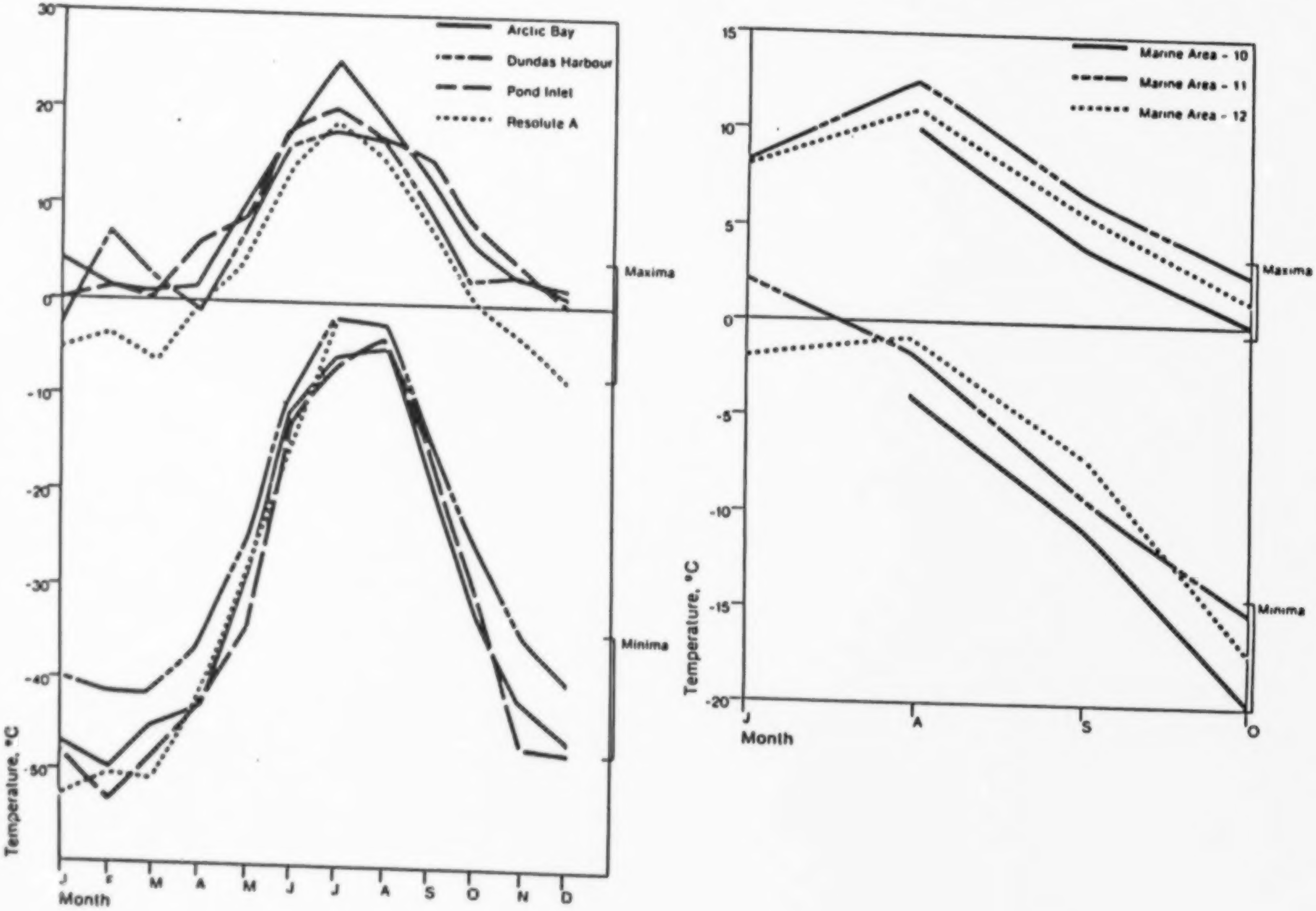


**Figure 2.48** Monthly extreme temperature values (see Figure 2.7 for zone locations) (from Maxwell, 1980).

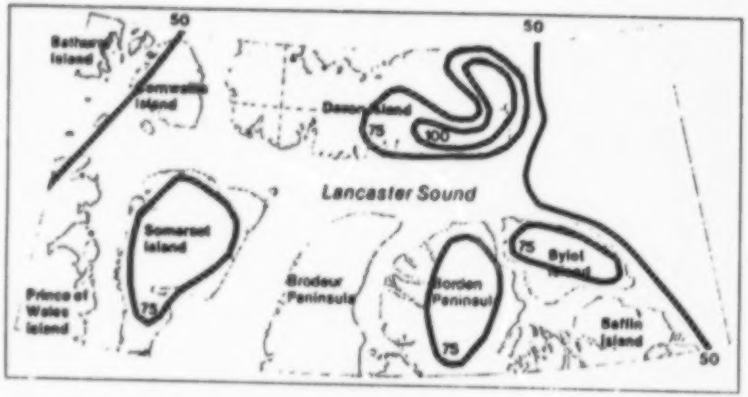

Bathurst Island
Cornwallis Island
Devon Island
Lancaster Sound
Somerset Island
Prince of Wales Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island
50
50
50
75
100
75
75
75
75

Figure 2.49 Mean annual rainfall (mm) (from Maxwell, 1980).

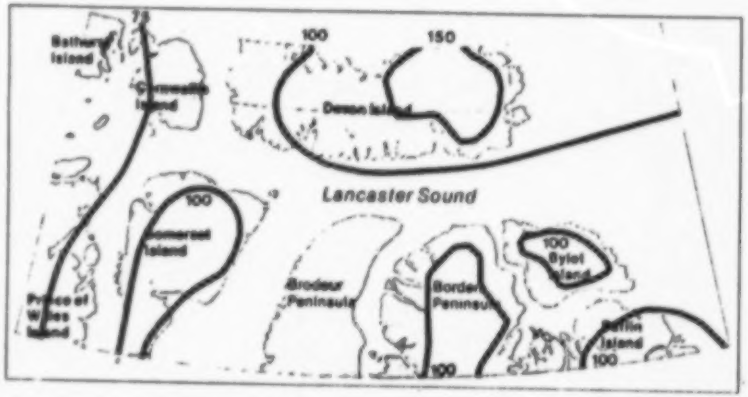

Bathurst Island
Cornwallis Island
Devon Island
Lancaster Sound
Somerset Island
Prince of Wales Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island
75
100
150
100
100
100
100

Figure 2.50 Mean annual snowfall (mm) (from Maxwell, 1980).

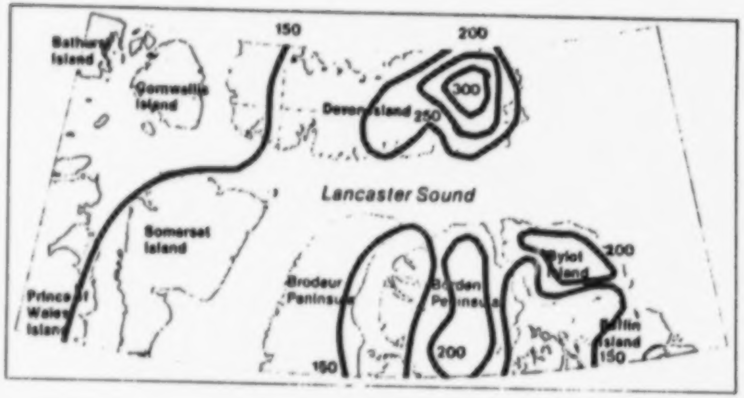

Bathurst Island
Cornwallis Island
Devon Island
Lancaster Sound
Somerset Island
Prince of Wales Island
Brodeur Peninsula
Borden Peninsula
Bylot Island
Baffin Island
150
200
300
250
200
200
150
150

Figure 2.51 Precipitation - mean annual (mm) (from Maxwell, 1980).

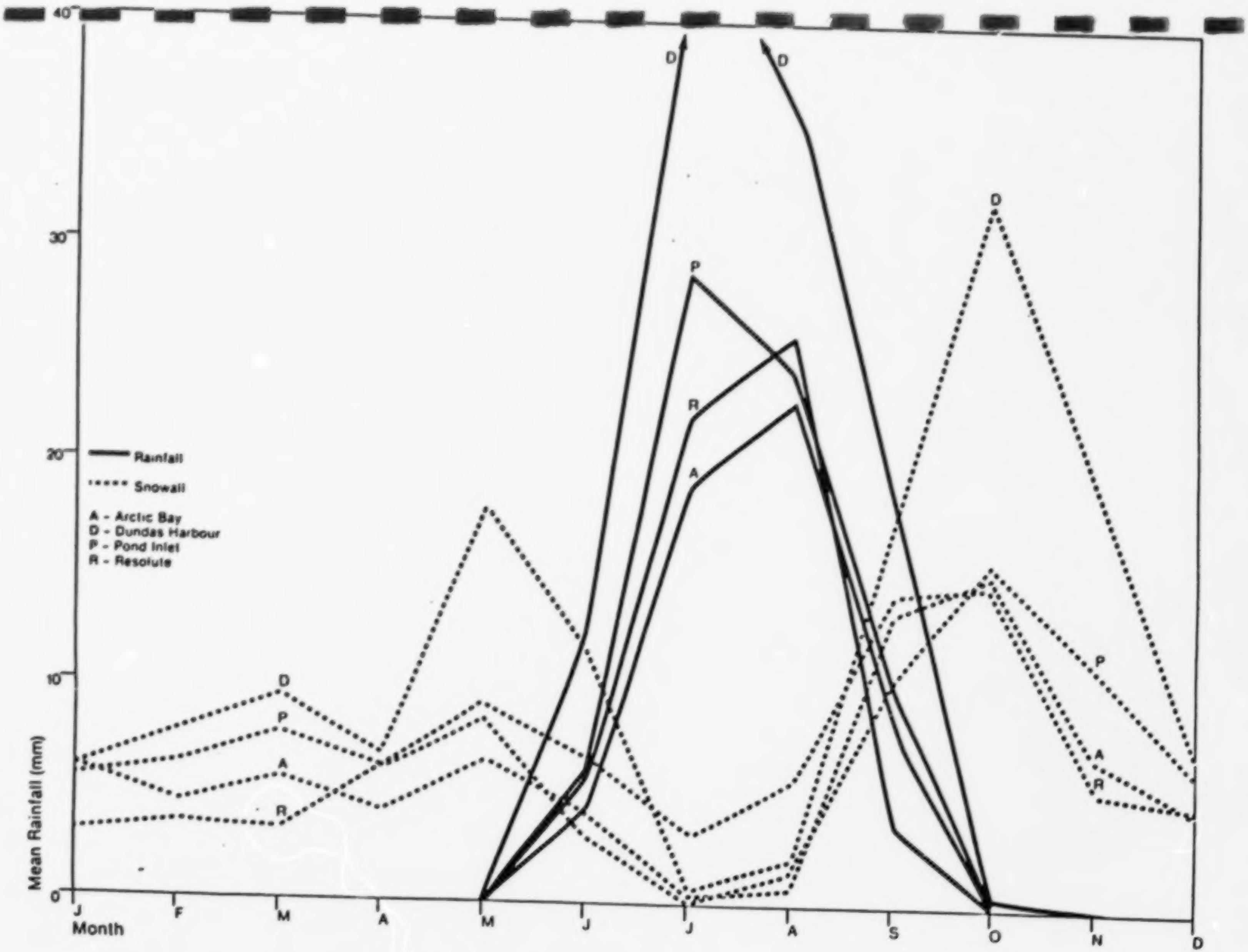


**Figure 2.52** Mean monthly rainfall and snowfall at coastal stations (from Maxwell, 1980).

## 2.4 MARINE HABITATS

Habitats within the study area which are associated with the marine environment must be considered to include not only the water areas but also the sea ice and coastal communities. The majority of the seabirds and marine mammals which rely on the sea for food, inhabit the ice edge and shore zone areas throughout their breeding and seasonal migration cycles.

### 2.4.1 Polynyas, Leads and Ice Edges.

The location and extent of polynyas, leads and ice edges have a special biological significance within the Lancaster Sound/Eclipse Sound region (see Section 2.2.2). Sea ice supports a surprisingly intense primary production within the ice itself. Ice edges are regions of special biological activity, and provide a solid platform for marine mammals (pinnipeds and polar bears). Polynyas, leads and other open water areas provide refugia for many sea mammals throughout the fall, winter and spring and for migrant sea birds in the spring and fall.

The growth of diatoms and other micro-organisms in sea ice has been observed for over a century (Dunbar, 1981). The most intense growth apparently begins in late winter or early spring, many weeks before the normal phytoplankton bloom in the water.

The ice edges are important to marine fish populations, and in particular to the arctic cod. Evidence that large populations of arctic cod concentrate along the open water leads and ice edges is found from studying the sea birds which feed on these species. Bradstreet (1977) observed that the stomach contents of murres feeding along the ice edge between Griffith and Beechey Island in 1976 consumed 1.4 million tons of arctic cod in a 33-day period. McAllister (1975) suggests that ice-associated fishes may in fact use the under-ice habitat on account of the defence it offers against predation by birds.

It is clear that the polynyas and lead systems have an important impact on the bird population within the study area. It is not a surprising coincidence that the major breeding sites on the northwest and southeast corners of Bylot Island (see Section 2.7) are close to the open water leads which develop at the mouth of Navy Board Inlet and Pond Inlet, respectively (Figures 2.34 and 2.35).

The ice edges and polynyas are an important habitat for marine mammals in particular as feeding and resting areas. During the winter, seals maintain breathing holes by abrading the ice along the ice edges and lead systems. The thin ice associated with polynyas and leads is important to the survival of these animals, in particular the sub-adult animals. Walrus generally stay in the Baffin Bay or Davis Strait areas during the winter where pack ice is thin and easy to break through, however they rely heavily on the open water leads which develop along the coast of Bylot and Devon Island in the spring as migration routes to new feeding sites. Similar migrations along polynyas and lead systems are well documented for spring and fall migrations of whales, such as the beluga and bowhead. It was this predictability of migration patterns that resulted in the near extinction of the bowhead by European whalers in the 19th century. The presence of polar bears along shore leads and polynyas in the winter and spring months is not surprising as seals are the main diet of these animals.

### 2.4.2 Coastal Habitats.

The coastlines of the Lancaster Sound/Eclipse Sound area are generally steep mountainous terrain interrupted by numerous dissecting valleys and drainage channels (see Section 2.1.3). Continuous beaches of predominantly coarse glacial material are common along most of the shore zones (Figure 2.9).

The ice-covered Byam Martin Mountains cover most of Bylot Island. On the western and northern coasts are lowlands sloping to sand and gravel or gravel beaches backed by low bluffs. The southeastern coast is steep, except where interrupted by broad, glacial valleys.

The coastal plain on Devon Island is of variable width, with discontinuous gravel and sand beaches (except Philpots Island, which is predominately boulder) backed by high, steep cliffs (especially along the southern coast; Sempel, 1982).

Northern Baffin Island is variable in habitat (e.g., the Brodeur Peninsula has a narrow coastal plain) and the Borden Peninsula has a broad coastal plain with low cliffs and deep river valleys.

The beaches of Navy Board Inlet are sand and gravel. This environment provides habitats for a large number of seabirds and marine mammals.

The steep rocky cliffs on the northwest and southeast corners of Bylot Island provide nesting sites for thick-billed murres, black-legged kittiwakes and black guillemots. The cliffs along the north coast of the Borden Peninsula between Cape Charles Yorke and Elwin Inlet host a major fulmar nesting colony. The coastal bluffs and wide plateau which extend across southwestern Bylot Island support a large colony of greater snow geese.

The low coastal areas and beaches along the shores of Bylot Island and Devon Island support large concentrations of seabirds during summer feeding periods. The low coastal area and beaches along the northeast shore of Navy Board Inlet and south shore of Devon Island near Dundas Harbour are well-documented sites of walrus haul-out (see Section 2.8). Polar bears use beach areas around Bylot Island and the northern Borden Peninsula extensively during the summer, hunting for seals.

Other processes that affect marine habitats are (1) ice activity and (2) freshwater input. The ice activity generally reduces species useage of nearshore habitats; first-year sea ice is bottom fast at water depths of less than 2 m and causes direct impact to organisms in this zone. In addition, scouring of sea ice above and below this zone also reduces available habitat in the supratidal and the nearshore areas. Consequently, the intertidal and nearshore areas are likely to have lower densities and diversities of marine organisms than offshore areas. Icebergs and sea ice may scour the seabed in deeper areas but generally less than 2% of the seabed is scoured in any one year, so offshore scouring is not likely to seriously affect species composition or diversity. The dynamic ice-front coasts are likely to have low species populations because of the very unstable conditions that exist at the ice fronts and also because of the very high sedimentation rates that occur there.

Freshwater input from surface runoff may create estuarine conditions in some bays and near river mouths. However, because snow melt runoff is strongly seasonal (early summer) and of short duration (often as short as a few days) these estuarine conditions are likely of short duration and may be of limited significance in life cycle history. Of greater significance is the seasonal sea ice melt that releases freshwater throughout the area. The melt may also allow "estuarine-like" conditions to persist over a comparatively long time period as an ice-front retreats.

### 2.4.3 Benthic Community

Benthic organisms are significantly influenced by both the physical habitat and water depth. Rock outcrops support a much different community than a sand/mud substrate.

Data on substrates are limited to sediments collected in association with benthic studies (Thomson and Cross, 1980; LGL, 1983) or very regional studies (e.g., Figure 2.53). At exposed sites in northern Baffin Bay and Lancaster Sound, such as those found at the mouth of Navy Board Inlet and along northern Bylot Island, shallow substrates (10m or less) are generally rocky and are backed by sand/cobble beaches. In the shallow waters of Pond Inlet and Eclipse Sound, sand and gravel substrates are more common. At greater depths, however, including those in Lancaster Sound, particle size decreases and the substrate consists of sands and muds (Figure 2.10). There is also less variability in substrate type in the deeper waters.

Sediment size and depth influence the species present. The shallow water fauna includes amphipods, mussels and polychaetes associated primarily with sand. The shallow water fauna within the euphotic zone (up to 50 m) also includes bivalves and polychaetes associated with sand and silt. Deeper water assemblages (50 - 250 m) include bivalves, starfish, brittlestars, and polychaetes in a variety of substrates. The deepest waters (250 - 1000 m) produce species with discrete depth and substrate preferences. These communities are illustrated in Figure 2.53.

Epifaunal species found in association with macrophytic growth on hard substrates include mussels, barnacles, starfish, sea urchins and shrimp.

### 2.4.4 Pelagic Habitat

The pelagic community is dependant on the primary producers (phytoplankton), whose biomass appears to be twice as high in Lancaster Sound as in other Arctic regions. This in turn supports a high zooplankton component including copepods, amphipods, chaetognaths and pteropods. Ichthyoplankton species include arctic cod, seasnails and snailfish. Zooplankton biomass appears to be considerably higher in Lancaster Sound than in other areas of the Arctic. Zooplankton provides the trophic link between the phytoplankton and the vertebrates, such as Arctic cod, seabirds and mammals.

## 2.5 MARINE INVERTEBRATES

Marine invertebrates can be found within the water column (i.e., pelagic) or associated with the bottom (i.e., benthic). The pelagic invertebrates, for example, copepods and amphipods, are described in Section 2.10 (Productivity). Three groups of benthic animals are generally recognized - infaunal, epibenthic and epifaunal. Infaunal organisms are those which live in the sediment. Most are relatively sessile and are either filter feeders or deposit feeders (those animals which feed on organic matter,

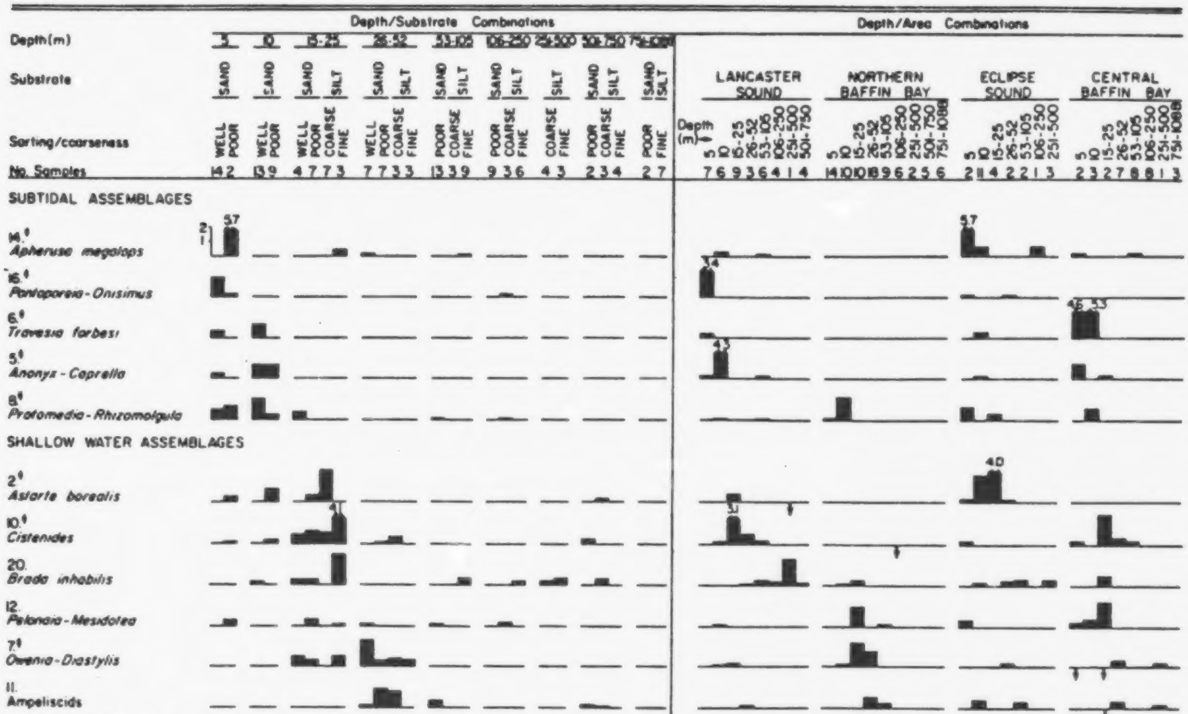


**Figure 2.53** Mean factor scores for various depth/substrate and depth/area combinations in eastern Lancaster Sound and western Baffin Bay. Values > 0.1 are denoted by a bar and values < - 0.1 are denoted by ↓ (from Thomson and Cross, 1980).

including bacteria in the sediment). Bivalves and polychaete worms are typical examples of infauna. Epibenthic animals are mobile, active organisms which remain closely associated with the substrate. The group, which includes decapods (shrimp), mysids, and some amphipods, are generally detritus feeders or scavengers. Epifaunal animals are those which are more or less permanently attached to the substrate and include barnacles, hydroids, anemones and mussels. Most are filter feeders.

Species distribution of benthic organisms varies with depth and substrate type. In the Lancaster Sound area, several depth ranges have been identified with the following general characteristics:

a) intertidal - that portion of the shore exposed during the period between successive high tides generally consists of cobble beaches with some areas of sand, mud or exposed bedrock. Very few species are present due to the influence of ice and cold temperatures. The main organisms are amphipods (e.g., Gammarus getosus; Onismus litoralis), which reside close to and follow the waterline.

b) 0 - 5 m - the substrate generally consists of cobble, changing to sand or mud within this range. The region is essentially barren except for a few amphipod species.

c) 5 - 50 m - this region represents the lower limit of the most productive zone and has the highest standing crop. Epibenthic crustacea such as mysids, amphipods and decapods are common as are bivalves and infaunal polychaetes.

d) > 50 m - within this zone the population density of organisms generally decreases with depth. There is a shift in the species present to infauna, especially polychaetes. Echinoderms are the most numerous epifaunal organisms.

The data base is insufficient to provide a regional assessment or to identify major differences between different water bodies. Major reports include those associated with E.A.M.E.S. (e.g., Thomson and Cross, 1980; LGL, 1983), BIOS (Cross et al., 1984), and regional environmental impact statements (LGL, 1982).

### 2.5.1 Infauna

Areas sampled for infauna by Thomson and Cross (1980) are shown in Figure 2.54. Sediments in Eclipse Sound tend to be finer than those in Lancaster Sound, while in northwest Baffin Bay, coarser material is present. Highest densities of infaunal organisms were found in Eclipse Sound, down to a depth of 250 m. The infaunal biomass in Lancaster Sound was lower, with maximum levels between 50 and 100 m. However, infaunal biomass was greatest in Lancaster Sound when averaged over all depths, followed by Eclipse Sound and Baffin Bay. These areas are considered to have higher biomass than other regions of the arctic, but less than in more temperate waters (LGL, 1982; 1983).

Filter feeders are dominant down to 250 m in Lancaster Sound, nourished by high current movement and primary production. Eclipse Sound also has high populations of filter feeders in shallow waters. Depth and geographical locations were found to be better predictors of benthic infaunal animals than were depth and substrate type (Thompson, 1982). Table 2.2 shows the results of a factor analysis of the 78 most abundant benthic organisms where 24 assemblages were identified. The first two are similar to the Macoma communities found in other areas of the arctic (Thompson, 1982). They are dominated by the bivalves Macoma and Astarte. Factor 1 correlates with a variety of depths and substrate types, while Factor 2 is associated with coarse silt and sand in a narrow depth range.

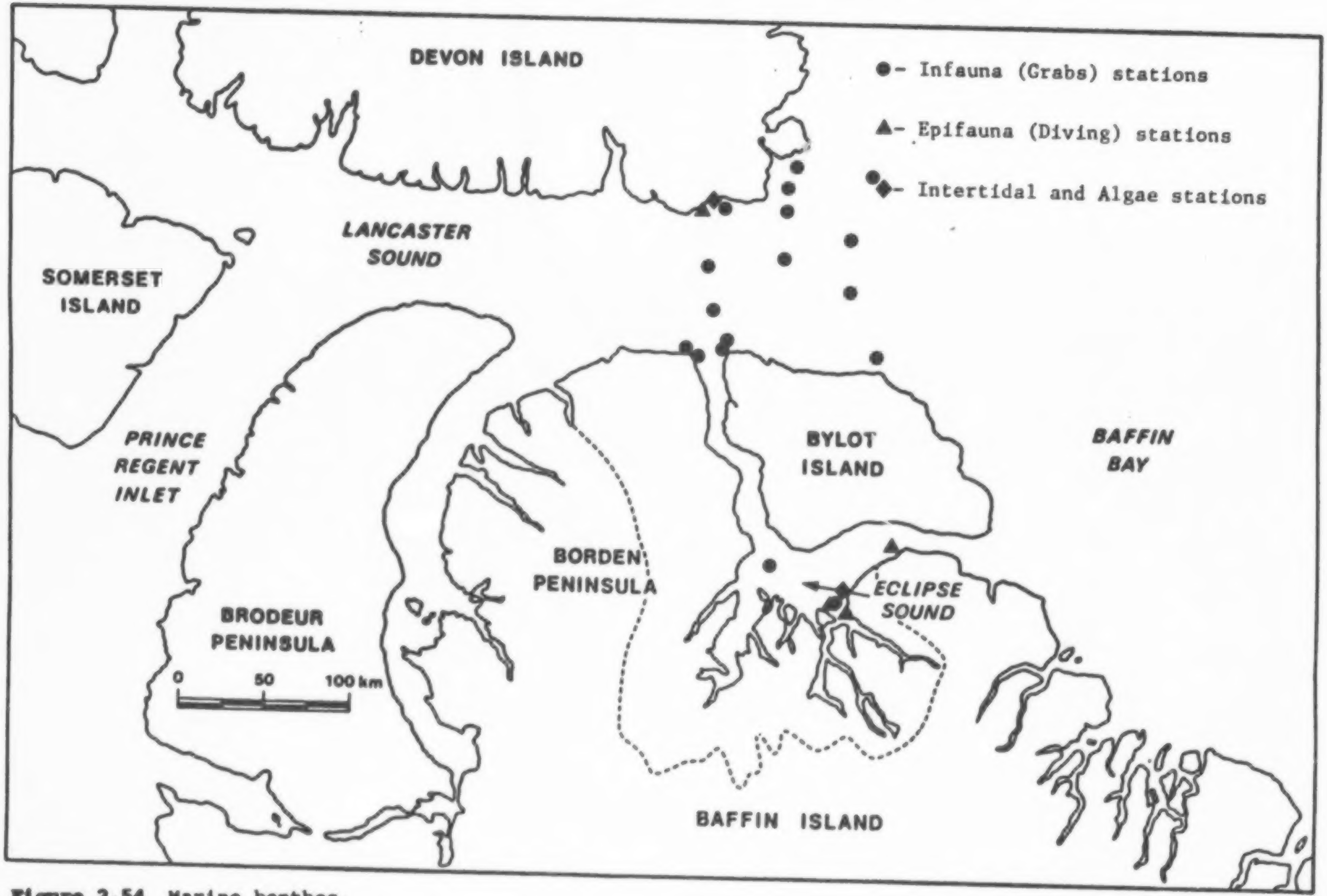

DEVON ISLAND
● - Infauna (Grabs) stations
▲ - Epifauna (Diving) stations
●◆ - Intertidal and Algae stations
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.54** Marine benthos.

**Table 2.2** Results of a factor analysis of the 78 most abundant benthic animals taken by grab and airlift in western Baffin Bay and Lancaster Sound in 1978 and 1979. The values shown are the correlations between the log-transformed abundances of various species (the original variables) and each of the 24 factors determined in the analysis. Species whose abundances were weakly correlated with a factor ($-0.4<\underline{r}<0.4$) are not shown. Each factor is assigned a name (beside number) indicating some or all of the main type(s) of animals represented (from Thomson, 1982).

| 1. *Macoma* - *Astarte* | |
|---|---|
| *Ophiura robusta* | 0.853 |
| *Lepeta caeca* | 0.789 |
| *Macoma calcarea* | 0.758 |
| *Brachydiastylis resima* | 0.727 |
| *Strongylocentrotus droebachiensis* | 0.703 |
| *Margarites* spp. | 0.694 |
| *Astarte montagui* | 0.687 |
| *Hiatella arctica* | 0.606 |
| *Ophiocten sericeum* | 0.512 |
| *Glycera capitata* | 0.481 |
| Ostracoda | 0.495 |

| 2. *Astarte borealis* | |
|---|---|
| *Astarte montagui* | 0.432 |
| *Macoma moesta* | 0.814 |
| *Guernea* sp. | 0.773 |
| *Astarte borealis* | 0.721 |
| *Serripes groenlandicus* | 0.649 |
| *Mya truncata* | 0.567 |
| *Phloe minuta* | 0.536 |
| *Musculus niger* | 0.520 |
| *Cistenides granulata* | 0.441 |
| *Ophilina aulogaster* | 0.472 |
| *Scoloplos armiger* | 0.474 |

| 3. Owenids | |
|---|---|
| *Ophiocten sericeum* | 0.424 |
| *Myriochele oculata* | 0.833 |
| *Myriochele heeri* | 0.786 |
| *Dacrydeum vitreum* | 0.737 |
| *Nephtys ciliata* | 0.560 |
| *Maldane sarsi* | 0.555 |
| Foraminifera | 0.548 |
| *Prionospio* spp. | 0.401 |
| *Cistenides hyperborea* | 0.499 |
| *Ophiura sarsi* | 0.412 |
| Ostracoda | 0.488 |

| 4. *Praxillura* - *Golfingia* | |
|---|---|
| *Paraxillura* spp. | 0.812 |
| *Golfingia margaritacea* | 0.699 |
| *Prionospio* spp. | 0.610 |
| *Glycera capitata* | 0.572 |
| *Onuphis conchylega* | 0.525 |
| *Asychis biceps* | 0.418 |
| *Ophiacantha bidentata* | 0.410 |

**Table 2.2** (continued)

| 5. *Anonyx* - *Caprella* | |
|---|---|
| *Anonyx sarsi* | 0.768 |
| *Caprella septentrionalis* | 0.659 |
| *Anonyx nugax* | 0.622 |
| *Marenzelleria wireni* | 0.570 |
| *Paroediceros lynceus* | 0.568 |
| *Atylus carinatus* | 0.508 |

| 6. *Travesia forbesi* | |
|---|---|
| *Anonyx laticoxae* | 0.812 |
| *Travesia forbesi* | 0.778 |
| *Monoculopsis longicornis* | 0.737 |
| *Lamprops fuscata* | 0.485 |

| 7. *Owenia* - *Diastylis* | |
|---|---|
| *Owenia fusiformis* | 0.786 |
| *Diastylis rathkei* | 0.752 |
| *Pelonaia corrugata* | 0.645 |

| 8. *Protomedia fasciata* | |
|---|---|
| *Protomedia fasciata* | 0.775 |
| *Rhizomolgula globularis* | 0.730 |
| *Capitella capitata* | 0.590 |
| *Chaetozone setosa* | 0.523 |
| *Lamprops fuscata* | 0.442 |

| 9. *Aglaophamus* - *Asychis* | |
|---|---|
| *Aglaophamus malmgreni* | 0.821 |
| *Asychis biceps* | 0.707 |
| Sipunculids | 0.528 |
| *Spiochaetopterus typicus* | 0.444 |

| 10. *Cistenides* | |
|---|---|
| *Cistenides granulata* | 0.670 |
| *Cistenides hyperborea* | 0.538 |
| *Atylus carinatus* | 0.523 |

| 11. Ampeliscids | |
|---|---|
| *Ampelisca escherichti* | 0.835 |
| *Byblis gaimardi* | 0.655 |
| *Scalibregma inflatum* | 0.413 |

| 12. *Pelonaia* - *Mesidotea* | |
|---|---|
| *Pelonaia corrugata* | 0.447 |
| *Thracia* sp. | 0.775 |
| *Mesidotea sabini* | 0.752 |

| 13. *Lumbrineris* - *Ascidia* | |
|---|---|
| *Lumbrineris fragilis* | 0.774 |
| *Ascidia callosa* | 0.744 |

| 14. *Apherusa megalops* | |
|---|---|
| *Apherusa megalops* | 0.783 |
| *Musculus discors* | 0.510 |

Table 2.2 (continued)

| | |
|---|---|
| 15. *Samythella* | |
| *Samythella neglecta* | 0.750 |
| *Thelepus cincinnatus* | 0.651 |
| *Ophiacantha bidentata* | 0.428 |
| 16. *Pontoporeia* - *Onisimus* | |
| *Pontoporeia affinis* | 0.901 |
| *Onisimus litoralis* | 0.682 |
| 17. *Bathyarca* - *Praxillella* | |
| *Bathyarca raridentata* | 0.781 |
| *Praxillella gracilis* | 0.771 |
| 18. *Ophiura sarsi* | |
| *Ophiura sarsi* | 0.652 |
| *Terebellides stroemi* | -0.416 |
| 19. *Musculus* | |
| *Musculus discors* | 0.441 |
| *Musculus niger* | 0.479 |
| *Scalibregma inflatum* | -0.558 |
| 20. *Brada inhabilis* | |
| *Brada inhabilis* | 0.691 |
| 21. *Nereis zonata* | |
| *Nereis zonata* | 0.862 |
| 22. *Polyphysia crassa* | |
| *Polyphysia crassa* | 0.907 |
| *Spiochaetopterus typicus* | 0.568 |
| 23. *Ctenodiscus* | |
| *Ctenodiscus crispatus* | 0.849 |
| 24. *Anonyx pacificus* | |
| *Anonyx pacificus* | 0.864 |

Deposit feeders were more often found at deeper depths, below 250 m, as illustrated in Table 2.3 (Thompson, 1982).

### 2.5.2 Epifauna

Quantitative studies of epifauna, those species attached to rock faces and other hard substrates, have not been carried out in the study area. Species commonly found among the algal growth include *Acmaea testudinalis* (limpet), *Tonicella marmorea* and *Lophyrochiton albus* (chitons), *Leptasterias polaris*, *Solaster papposus* (sea stars) and *Strongylocentrotus droebachiensis* (sea urchin). Sea anemones, the bivalves *Hiatella arctica* and *Musculus discors*, sea cucumbers (*Psolus* sp.), barnacles (*Balanus crenalus*) and sponges were also recorded (Thomson and Cross, 1980).

The species observed do not appear to be unique to the area (LGL, 1983). Their contribution to the total biomass of the Lancaster Sound region is not known, but records of very high benthic biomass resulting from epifaunal organisms have been reported elsewhere in arctic regions (LGL, 1983).

### 2.5.3 Epibenthic organisms

Amphipods were the dominant animals found in the intertidal and shallow subtidal areas, with *Gammarus setosus* and *Onisimus litoralis* accounting for most of the specimens (Thomson and Cross, 1980). Extremes in temperature and salinity, ice and lack of marine algae are the main factors limiting the presence of most species. Mysids (*Mysis oculata*, *M. litoralis*) also can be found in shallow depths. These animals form an important link in the diets of arctic char, shorebirds and some seabirds and ringed seals (Thomson and Cross, 1980).

Table 2.3 Mean biomass of samples with factor scores > 1.0 for the indicated factors (from Table 2.2). Only factors with high scores at depths > 15 m are considered. The locations from which most of these samples were taken and the feeding modes of the species most characteristic of each factor are also shown.

| Factor | Name | No. of samples | Biomass mean ± SD | Feeding mode[a] | Location |
|---|---|---|---|---|---|
| <250 m | | | | | |
| 10. | *Cistenides* | 17 | 633 ± 542 | DF | Lancaster Sound/Scott Inlet/Eclipse Sound (shallow) |
| 1. | *Macoma* - *Astarte* | 30 | 529 ± 350 | DF/SF | Lancaster Sound/Philpots Island |
| 2. | *Astarte borealis* | 14 | 516 ± 370 | DF/SF | Eclipse Sound (shallow) |
| 19. | *Musculus* | 18 | 502 ± 348 | SF | Philpots Island/Lancaster Sound/Eclipse Sound (shallow)<br>Bylot Island/Philpots Island |
| 7. | *Owenia* - *Diastylis* | 25 | 379 ± 415 | SF/DF | Bylot Island |
| 3. | *Owenida* | 21 | 99 ± 139 | DF | Scott Inlet/Eclipse Sound (deep) |
| 13. | *Lumbrineris* - *Ascidia* | 3 | 733 ± 778 | DF/SF | Lancaster Sound |
| >250 m | | | | | |
| 23. | *Ctenodiscus* | 3 | 25 ± 5 | DF | Eclipse Sound |
| 9. | *Aglaophamus* - *Amychis* | 16 | 61 ± 97 | DF | All deep water except Eclipse Sound |
| 4. | *Praxillura* - *Golfingia* | 14 | 160 ± 216 | DF | Lancaster Sound/northwest Baffin Bay |
| 15. | *Samythella* | 7 | 27 ± 10 | DF | Lancaster Sound/northwest Baffin Bay |
| 22. | *Polyphysia crassa* | 5 | 26 ± 21 | DF | Eclipse Sound/northwest Baffin Bay |
| 17. | *Bathyarca* - *Praxillella* | 7 | 17 ± 13 | SF/DF | Eclipse Sound/central Baffin Bay |

SF = suspension feeder, DF = deposit feeder (from Thomson, 1982)

## 2.6 MARINE FISH

Detailed studies on marine fish in the Lancaster Sound area have not been carried out. Data are limited to lists of species and some distribution information. Some data are available in the environmental impact statements for the region (LGL, 1982, 1983; Norlands Petroleum Limited, 1978).

Compared to waters west of Greenland, where 86 fish species are known to occur, the study area is somewhat impoverished (LGL, 1982). Only 27 species have been reported (Table 2.4), although the lack of detailed surveys may be partially responsible for the shorter list. Most species, with the exception of juvenile cods, arctic char and Greenland shark, are bottom dwellers. The two most important species, arctic char and arctic cod, are discussed separately in the following sections.

### 2.6.1 Arctic char

Char (Salvelinus alpinus) are anadromous fish, migrating to the sea each spring and returning to fresh water ponds in the fall. Most appear to remain within 30 to 40 km of their natal streams. They feed in the shallow coastal areas where water is warmer and less saline; amphipods form the main part of their diet.

Many inlets have potential spawning/wintering rivers. The required criteria include the presence of pools or lakes greater than 2 m deep, absence of high waterfalls, large enough drainage area to provide year-round water supply and no glaciers (e.g., little siltation).

Spawning sites have not been documented in Lancaster Sound. However, in the Eclipse Sound/Navy Board Inlet/Pond Inlet areas two large spawning rivers are known: Salmon River with an annual run of 100,000 adults; and

**Table 2.4 Common and scientific names[1] of fish species known or suspected to occur in Lancaster Sound, west Baffin Bay and immediately adjacent waters (from LGL, 1983; National Museum of Canada computer files).**

| Name | |
|---|---|
| Scientific | Common |
| Squalidae | |
| Somniosus microcephalus | Greenland shark |
| Rajidae | |
| Raja hyperborea | darkbelly skate |
| Salmonidae | |
| Salvelinus alpinus | arctic char |
| Gadidae | |
| Arctogadus glacialis | polar cod |
| *Arctogadus borisovi | |
| Boreogadus saida | arctic cod |
| Gadus ogac | Greenland cod |
| Macrouridae | |
| Coryphaenoides rupestris | rock grenadier |
| Zoarcidae | |
| Gymnelis viridis | fish doctor |
| *Gymnelis retrodorsalis | |
| Lycodes mucosus | saddled eelpout |
| Lycodes polaris | polar eelpout |
| *Lycodes pallidus | |
| Agonidae | |
| Agonus decagonus | sea poacher |
| Cottidae | |
| Artediellus scaber | rough hookear |
| Gymnocanthus tricuspis | arctic staghorn |
| Icelus bicornis | twohorn sculpin |
| Icelus spatula | spatulate sculpin |
| Myoxocephalus quadricornis | fourhorn sculpin |
| Myoxocephalus scorpiodes | arctic sculpin |
| Myoxocephalus scorpius | shorthorn sculpin |
| Triglops pingelii | ribbed sculpin |
| *Triglops nybelini | |

**Table 2.4** (continued)

| Name | |
|---|---|
| Scientific | Common |
| Cyclopteridae | |
| *Cyclopteropsis jordani* | smooth lumpfish |
| *Eumicrotremus derjugini* | leatherfin lumpsucker |
| *Eumicrotremus spinosus* | Atlantic spiny lumpsucker |
| *Liparis tunicatus* | Greenland seasnail |
| *Liparis gibbus*[2] | dusky snailfish |
| *Liparis fabricii*[2] | gelatinous seasnail |
| **Careproctus reinhardti* | |
| Pleuronectidae | |
| *Reinhardtius hippoglossoides* | Greenland halibut |
| Gonostomatidae | |
| *Cyclothone microdon* | veiled anglemouth |
| Scorpaenidae | |
| *Sebastes marinus* | redfish |

---

[1] Scientific and common names are from Legendre *et al* (1975) and Leim and Scott (1966).

[2] Reported as *L. cyclostigma* and *L. koefoedi* by Sekerak *et al* (1979). Differences are due to recent changes in scientific nomenclature.

* Species from National Museum files.

Robertson River with 500,000 adults. A number of other potential sites have been identified, but not studied to date. These are shown in Figure 2.55.

### 2.6.2 Arctic Cod

Arctic cod (Boreogadus saida) are very abundant and considered a critical link in many of the food webs of the arctic. Many seals, seabirds, toothed whales and char are dependant on this small cod for their diet. Changes in the cod population could have serious implications since there are few alternative food sources in arctic waters.

In spite of its importance, little is known about the biology of the cod. They spawn in January-February, with the young, which are planktonic, concentrated in the upper 20-30 m of the water column. However, specific spawning sites have not been identified.

The species is common throughout its polar range, although few measurements of abundance have been undertaken. Estimates made by LGL (1983) indicate a standing stock of at least 400,000 tonnes in Lancaster Sound. Ichthyoplankton surveys indicate that arctic cod are nearly twice as abundant in Lancaster Sound as in other arctic regions (Norlands Petroleum Limited, 1978).

### 2.6.3 Other Species

Two other species of cod, Greenland cod (Gadus ogac) and polar cod (Arctogadus glacialis) appear to be rare in the study area.

Greenland halibut are found in deep waters. They have been taken by longline in Pond Inlet and frequently are found in the stomachs of narwhals and hooded seals in the Pond Inlet area. Redfish (Sebastes marinus) also have been found as part of the diet of narwhals (Finley and Gibb, 1982).

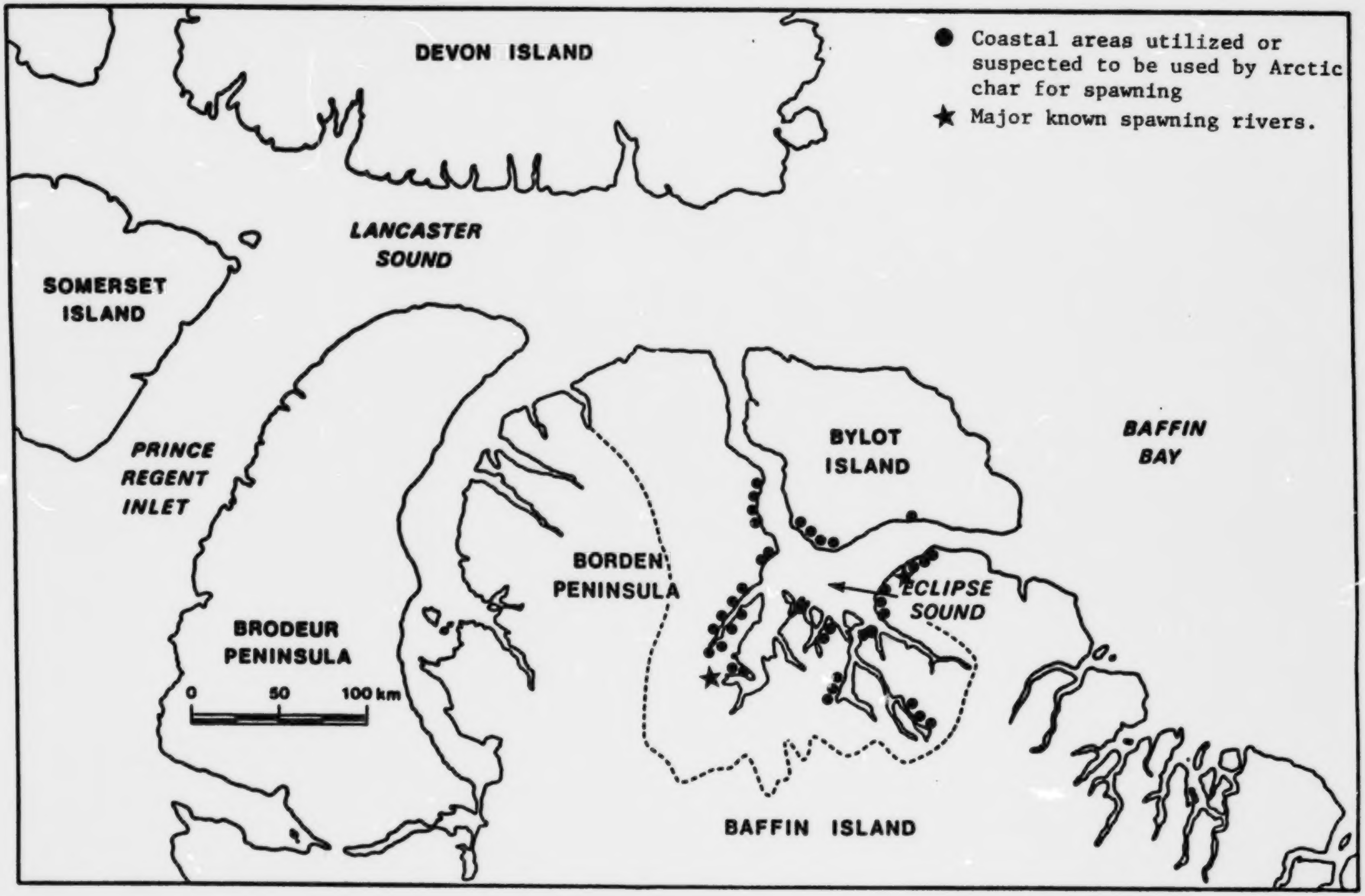

DEVON ISLAND
● Coastal areas utilized or suspected to be used by Arctic char for spawning
★ Major known spawning rivers.
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BRODEUR PENINSULA
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
ECLIPSE SOUND
BAFFIN ISLAND
0
50
100 km

Figure 2.55 Marine fish

Greenland sharks (Somniosus microcephalus) have occasionally been captured in Pond Inlet feeding on offal from sealing or whaling operations (Beck and Mansfield, 1969).

The remaining species recorded from the study area are primarily bottom dwellers. The most common are the sculpins, particularly two species - Gymnocanthus tricuspis and Myoxocephalus scorpius (Thomson et al., 1979).

## 2.7 SEABIRDS

Large numbers of marine birds either migrate through, or summer in, the Lancaster Sound area. Several of the summer residents occur in numbers large enough to be of regional and national significance. These species are discussed collectively below, while information on individual species is presented in subsequent sections.

The information in the following section was summarized from a large number of reports (Bradstreet, 1976; Johnson et al., 1976; McLaren, 1980, 1982; McLaren et al., 1979; McLaren and McLaren, 1982; Nettleship, 1974; Nettleship and Gaston, 1978; and in environmental impact statements such as CMO, 1983; LGL, 1982, 1983; Norlands Petroleum Limited, 1978; Petro-Canada, 1982; Lancaster Sound Regional Study, 1980a, 1980b).

Many seabirds nest in large colonies and two such areas exist on Bylot Island; Cape Hay, near the northwest corner, and Cape Graham Moore on the southeast corner. Cape Hay is estimated to have over 280,000 thick-billed murres, 40,000 black-legged kittiwakes and 100 black guillemots; 40,000 murres, 6,000 kittiwakes and an undetermined number of guillemots nest at Cape Graham Moore. All of Bylot Island has been designated as a migratory bird sanctuary, particularly for the protection of nesting colonies of murres, black-legged kittiwakes and greater snow geese.

Other nesting sites are found on the south shore of Devon Island (Hobhouse Inlet - 75,000 fulmars; guillemots, gulls), at Prince Leopold Island (124,000 fulmars, 38,000 kittiwakes, 112,000 murres and 4,000 guillemots), and at Baillarge Bay (50,000 fulmars) on the Borden Penninsula (Figure 2.56).

With respect to the regional significance of Lancaster Sound, an estimated 152,000 pairs of fulmars nest in the study area or in colonies to the west, representing 70% of the Canadian population; 45% of breeding fulmars regularly use Lancaster Sound. For the black-legged kittiwake, nearly the entire arctic population utilizes the Lancaster Sound region, a number which represents 46% of the eastern Canadian population.

Over 1,000,000 thick-billed murres (33% of Canadian arctic population) are thought to use the waters of Lancaster Sound and surrounding areas. Dovekies, while they do not nest in Canada, are also present in enormous numbers during migration (e.g., 14,000,000 during May, 1978), which probably represents a substantial portion of the total population nesting in Greenland.

Other important bird species include the eiders (common and king), which heavily utilize the Lancaster Sound region both as breeding and summer feeding areas and the greater snow goose, where 15,000 - 20,000 birds, about 33% of the world population, nest on the lowland tundra of southwestern Bylot Island.

### 2.7.1 Procellariiformes

#### Northern Fulmar (Fulmarus glacialis)

Several colonies of fulmars nest in the study area. Spring migration begins in late April and by May, fulmars are common in the study area. Fulmars follow the edge of fast ice along the north and east coasts of

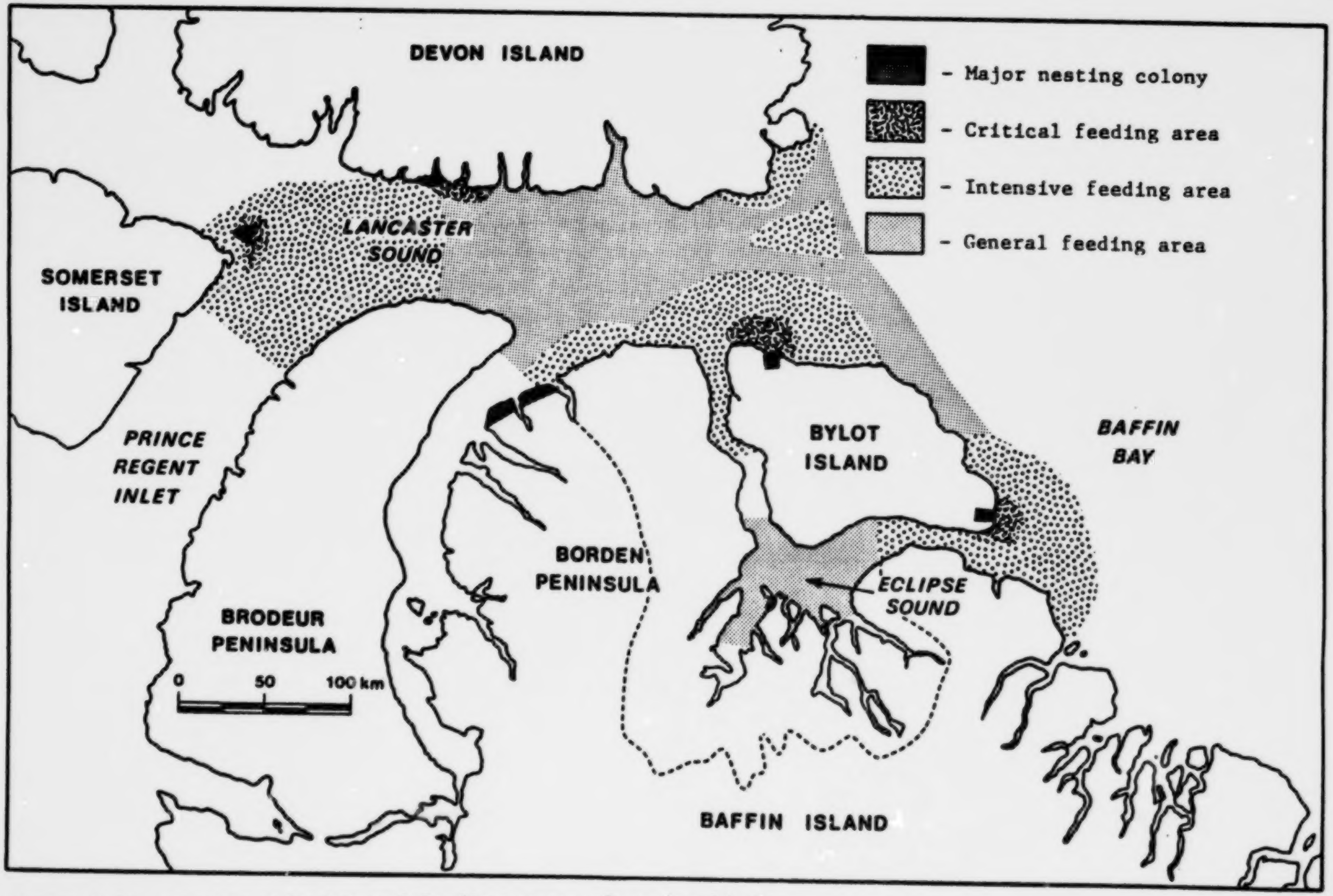

DEVON ISLAND
SOMERSET ISLAND
LANCASTER SOUND
PRINCE REGENT INLET
BRODEUR PENINSULA
BORDEN PENINSULA
BYLOT ISLAND
ECLIPSE SOUND
BAFFIN BAY
BAFFIN ISLAND
0
50
100 km
- Major nesting colony
- Critical feeding area
- Intensive feeding area
- General feeding area

**Figure 2.56** Nesting colonies and feeding areas of marine birds.

Bylot Island and along the mouth of both Pond Inlet and Navy Board Inlet. During the summer, an estimated 52,000 individuals are believed to reside in Lancaster Sound (Figure 2.57).

In late August and September, fulmars concentrate in small areas, especially along the southwest of Devon Island, the northeast and east coast of Bylot Island and the mouth of Pond Inlet. Southward migration occurs in mid-September.

### 2.7.2 Charadriiformes

#### Glaucous Gulls (Larus hyperboreus)

This species is common and nests throughout the Canadian arctic. Colonies are found on cliffs or islands along the southeastern, western and northwestern coasts of Bylot Island.

Spring migration occurs between April and June, with the birds following the coastline and edge of the fast ice. Nesting begins in late May, with fledging occurring between mid-August and early September. During the summer, large numbers can be found along the east coast of Bylot Island and in Pond Inlet. In the fall, glaucous gulls are frequently found in Navy Board Inlet, Eclipse Sound and Pond Inlet, as well as the south coast of Devon Island. Migration from the area generally begins during mid to late September (Figure 2.58).

#### Black-legged Kittiwake (Rissa tridactyla)

This species is a common resident in the Lancaster Sound region, being frequently found along the coast and fast-ice edges, especially those of Bylot Island. The density and distribution of kittiwakes are related to ice conditions as they prefer open waters with little or no pack ice. Large colonies are found on Bylot Island and other regions of Lancaster Sound (Figure 2.59). During nesting, adults tend to stay near the colonies, feeding in adjacent waters on crustaceans, especially near glacier fronts.

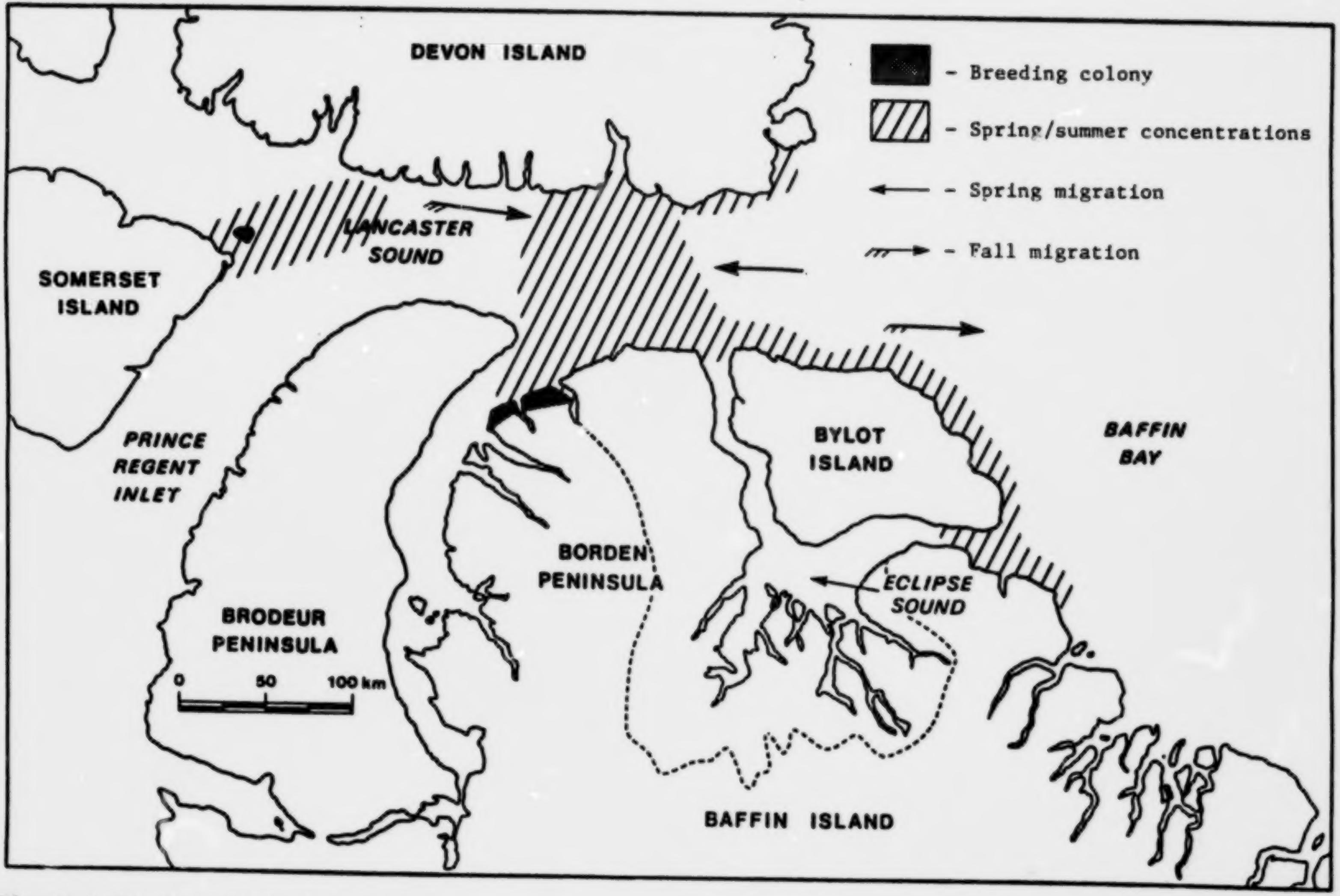

DEVON ISLAND
■ - Breeding colony
▨ - Spring/summer concentrations
← - Spring migration
→ - Fall migration
SOMERSET ISLAND
LANCASTER SOUND
PRINCE REGENT INLET
BRODEUR PENINSULA
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
ECLIPSE SOUND
BAFFIN ISLAND
0
50
100 km

**Figure 2.57** Distribution of fulmars.

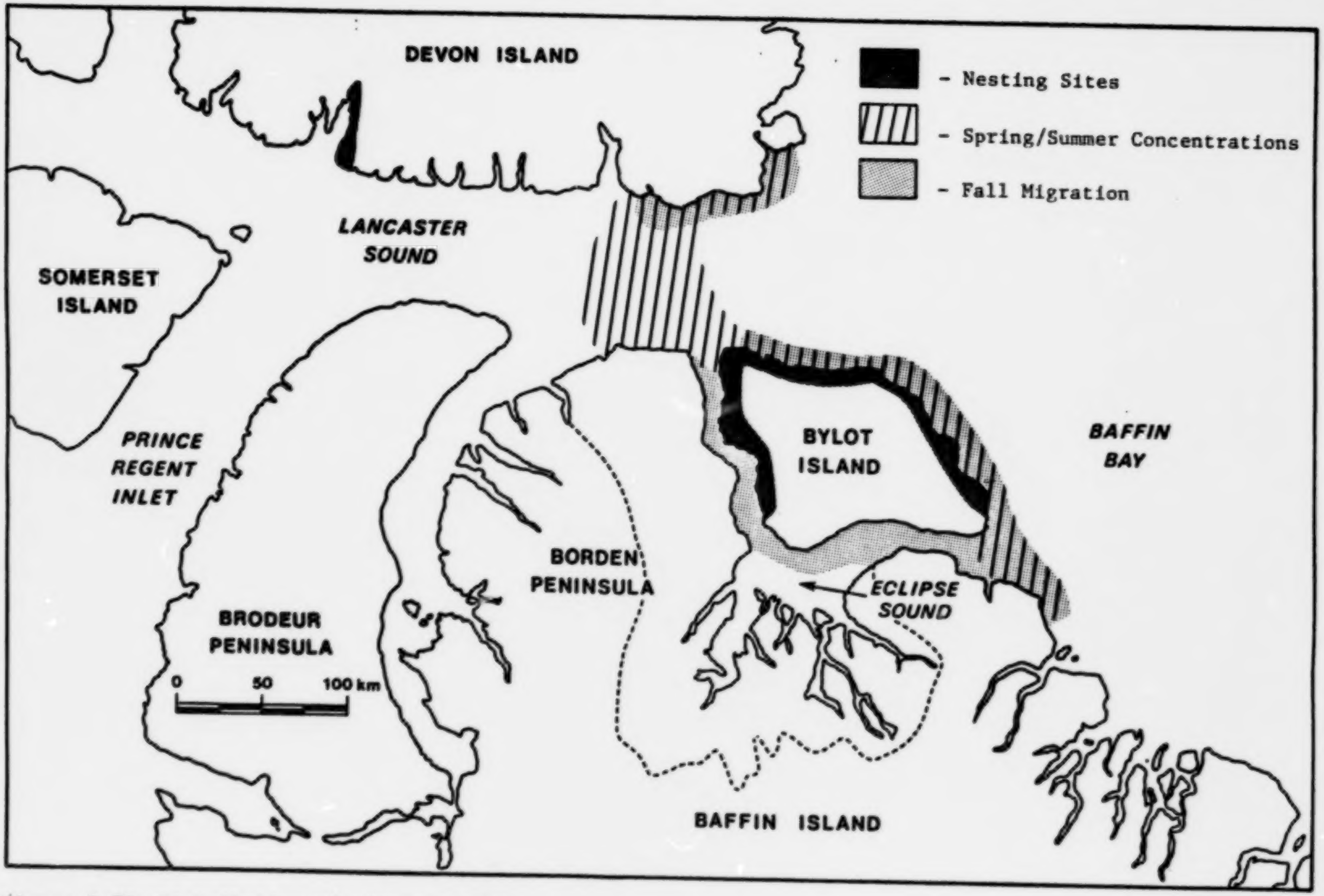

DEVON ISLAND
- Nesting Sites
- Spring/Summer Concentrations
- Fall Migration
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

Figure 2.58 Distribution of glaucous gull.

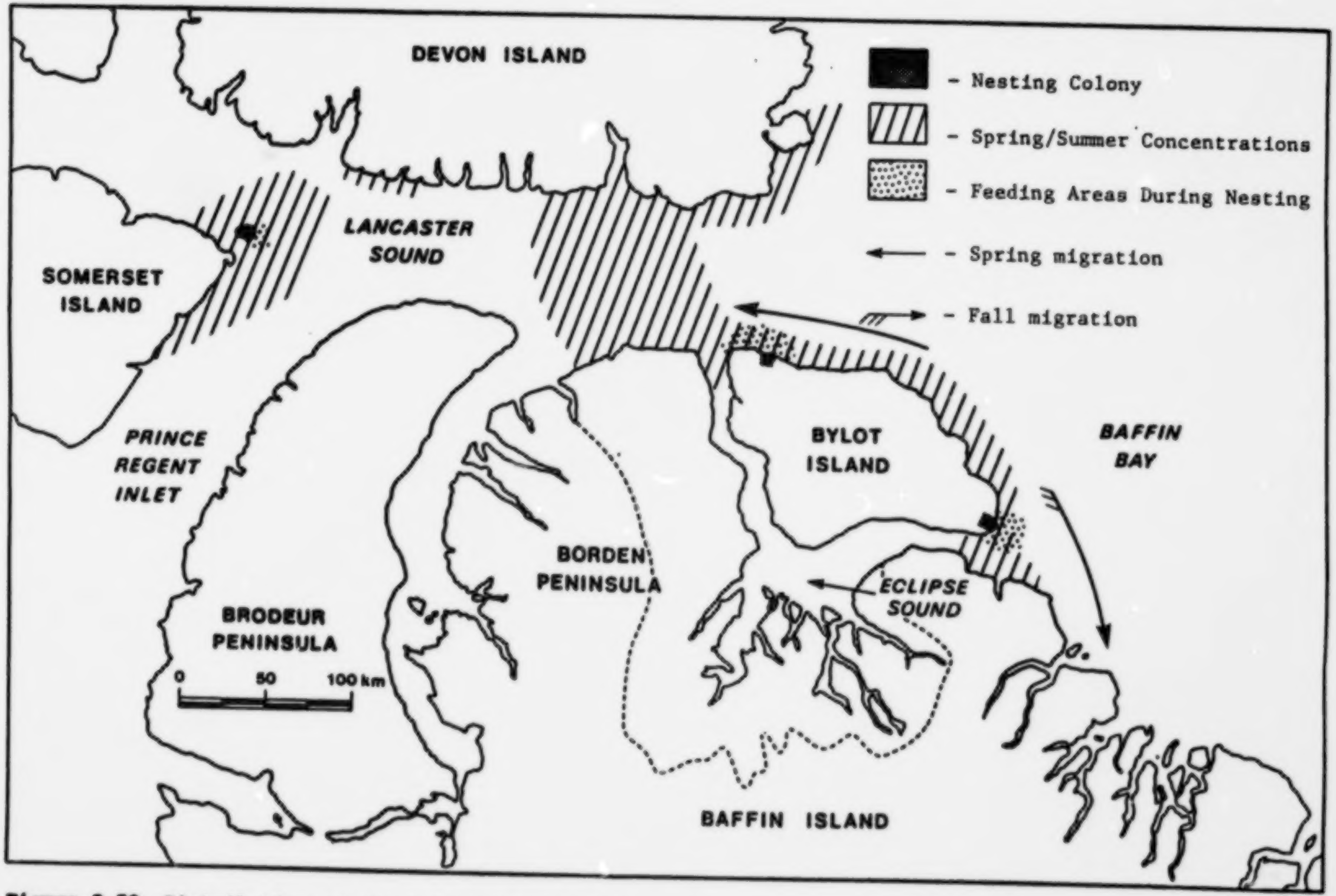

DEVON ISLAND
■ - Nesting Colony
▨ - Spring/Summer Concentrations
░ - Feeding Areas During Nesting
← - Spring migration
→ - Fall migration
SOMERSET ISLAND
LANCASTER SOUND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.59** Distribution of black-legged kittiwake.

Spring migrants follow the fast-ice edge, arriving about mid-May, some passing through to colonies in the central arctic. By mid-June, kittiwakes are common along the coasts and fast-ice edges of Lancaster Sound and south coast of Devon Island. The species remains in the region until mid-October, then follows the coast of Baffin Island south.

Dovekie (Plautus alle)

While the dovekie does not nest in the study area, up to 15 million birds may use Lancaster Sound during the spring migration. The birds are found primarily offshore rather than concentrating along the edges of landfast ice. They winter along the edge of the pack ice from the Gulf of St. Lawrence to west of Greenland, migrating to nesting sites in Greenland, primarily in May. Fall migrants appear in late August and September, although the numbers are not as great as in the spring (Figure 2.60).

Black Guillemot (Cepphus grylle)

The black guillemot is a common, widely-distributed seabird which nests in scattered pairs along coastlines throughout the eastern arctic. Small colonies (100-400 birds) are found at Cape Hay and Cape Graham Moore on Bylot Island, Hobhouse Inlet and Cape Liddon on Devon Island, and Cape Searle on Baffin Island. A large colony of 8,400 birds is located at Prince Leopold Island to the west of Lancaster Sound (Figure 2.61).

Most migrants arrive in May, widespread throughout the offshore pack ice, although large numbers also follow the fast ice edges along the coast of Bylot Island and the mouth of Pond Inlet.

Nesting begins in June and during this period the adults remain near the nesting sites. The young fledge by the end of August after which the population becomes widespread throughout the area until freezeup in October.

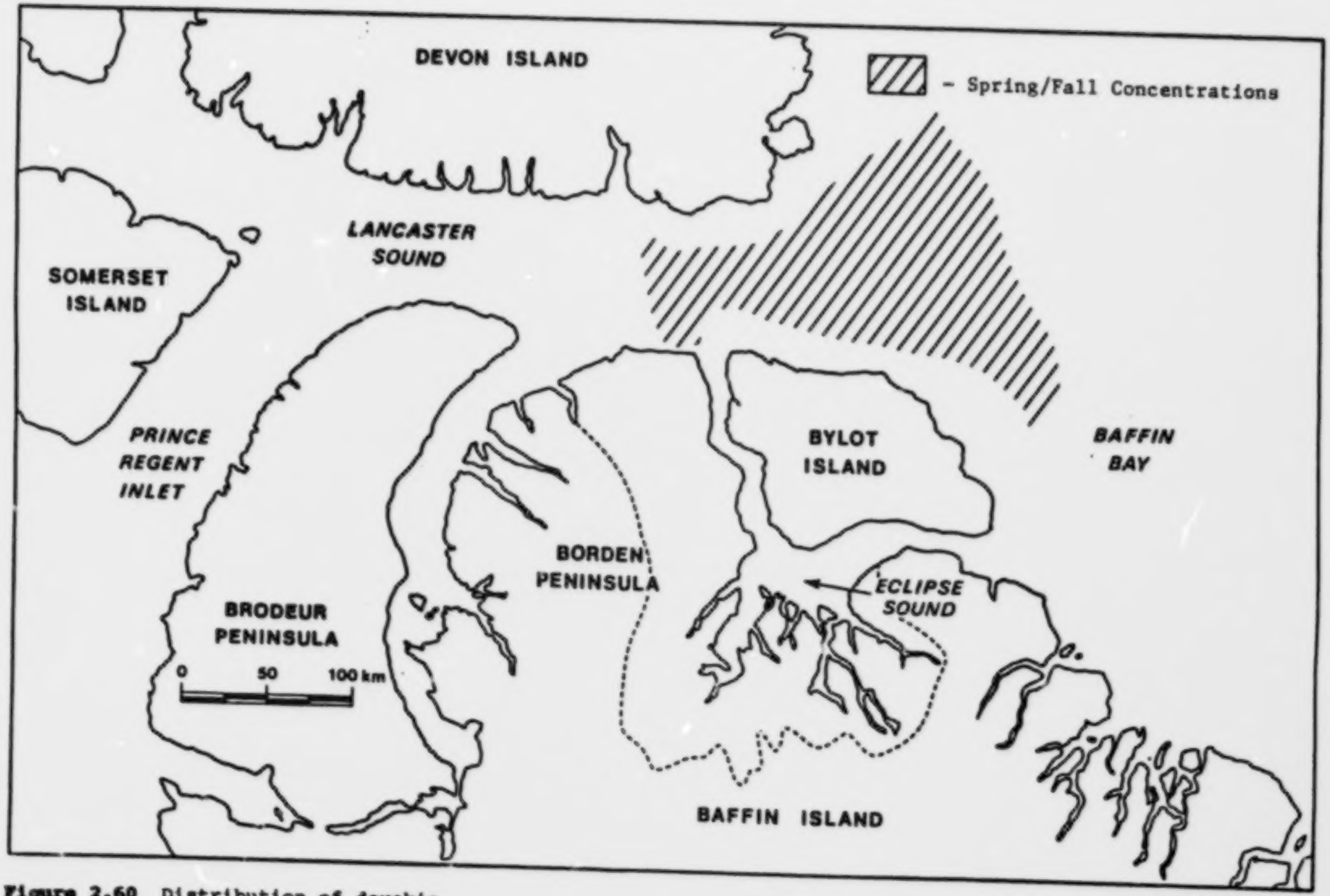

DEVON ISLAND
- Spring/Fall Concentrations
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.60** Distribution of dovekie.

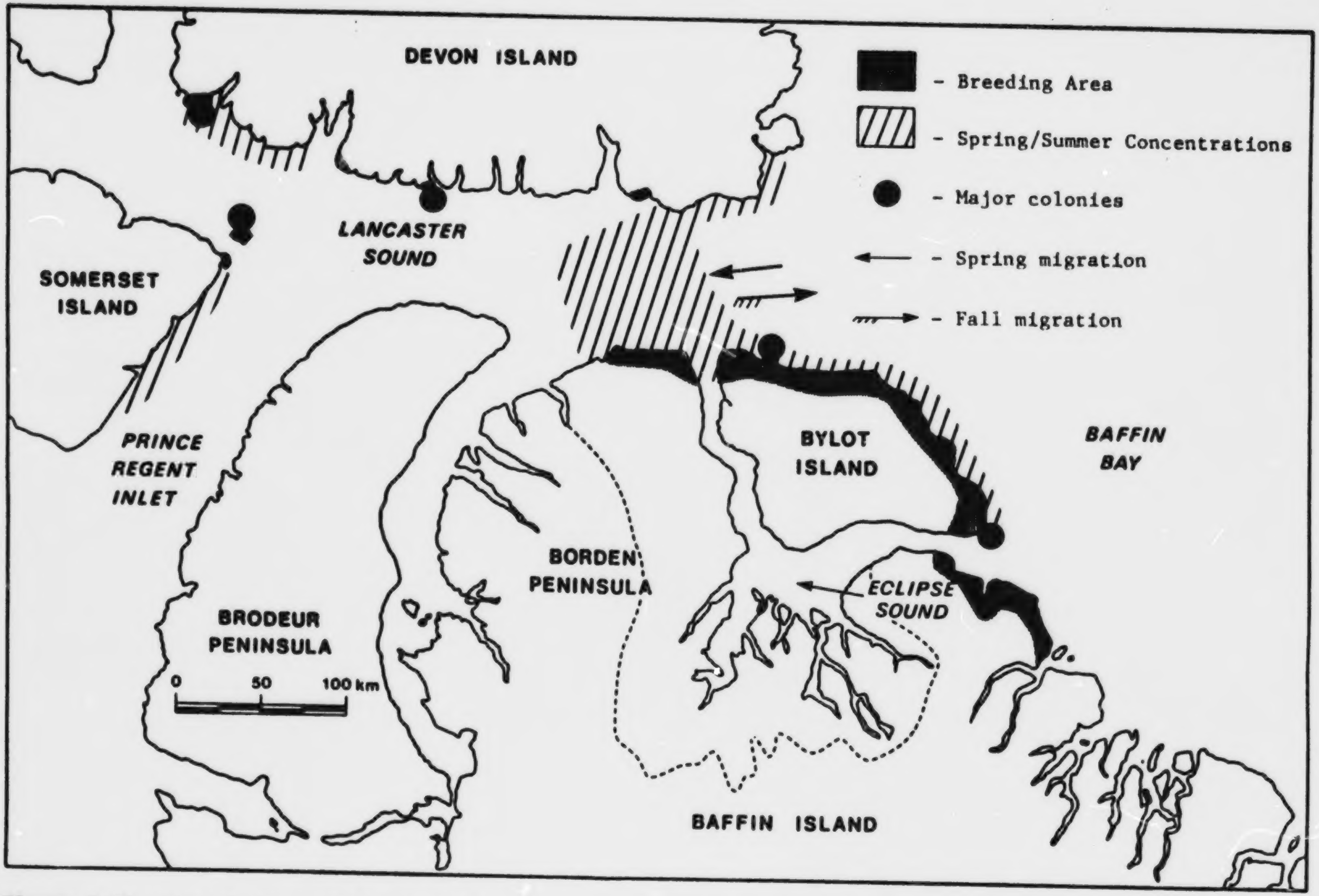

DEVON ISLAND
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BRODEUR PENINSULA
BORDEN PENINSULA
BYLOT ISLAND
ECLIPSE SOUND
BAFFIN BAY
BAFFIN ISLAND
0
50
100 km
- Breeding Area
- Spring/Summer Concentrations
- Major colonies
- Spring migration
- Fall migration

**Figure 2.61** Distribution of black guillemot.

Thick-billed Murre (Uria lomvia)

Murres nest in large colonies and two major ones are found on Bylot Island (Figure 2.62). They prefer nearshore waters along the coast or along the edge of fast ice.

Spring migration begins in May and as many as 500,000 birds may be found offshore in Lancaster Sound. However, by late May they start moving inshore along the coast.

Nesting begins in late June. During this period the adults remain fairly close to the colony. The young fledge by late September when they begin a swimming migration out to sea, accompanied by adults who are in molt.

This swimming migration makes the murre particularly susceptible to oil spills. Murres are common in Lancaster Sound and represent a significant portion of the total population of murres. Some data suggest, however, that there has been a recent population decline. The reasons for this are not known but may include shooting, gillnets and oiling. This decline and their susceptibility during the swimming migration have resulted in murres being considered a threatened species.

Other Charadriiformes

Red phalaropes (Phalaropus fulicarius) are a common arctic bird, nesting near ponds on the tundra of many of the islands. They are common along the southwestern coast of Bylot Island.

All three species of jaegers - pomarine (Stercorarius pomarinus), parasitic (S. parasiticus) and long-tailed (S. longicaudus) - nest in suitable areas (lowland tundra), including southwestern Bylot Island. None of these species are common, however.

Gulls such as the great black-backed (Larus marinus), Thayers (L. theyeri), and Sabine's gull (Xema sabini) are rare or uncommon. Nesting has been reported to occur on southwest Bylot Island. Arctic terns are present in moderate densities, but Lancaster Sound is also used as part of the

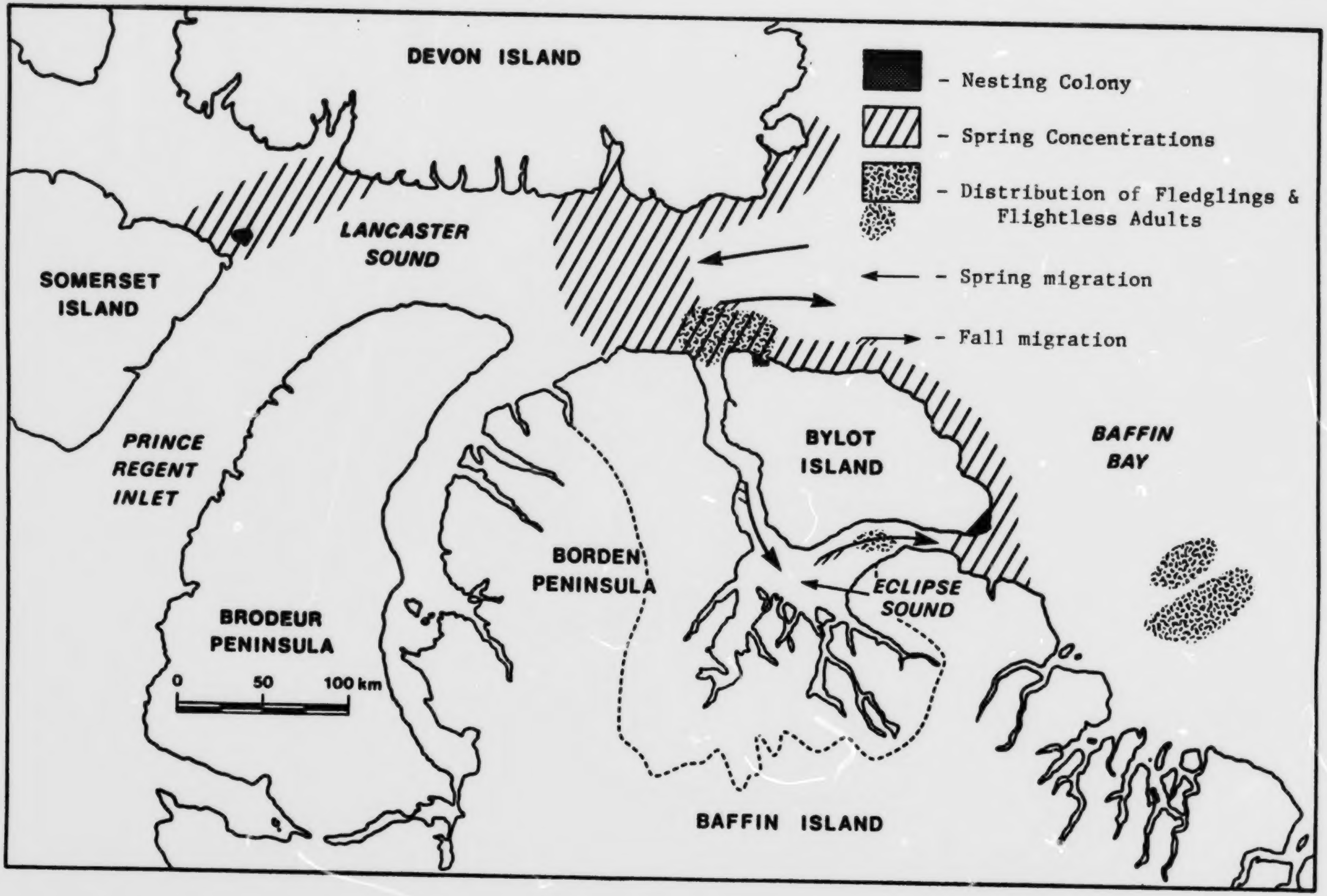

DEVON ISLAND
- Nesting Colony
- Spring Concentrations
- Distribution of Fledglings & Flightless Adults
- Spring migration
- Fall migration
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.62** Distribution of thick-billed murre.

migration route to nesting sites further north and west. The arctic terns (Sterna paradisaea) also nest on the southwestern and eastern coasts of Bylot Island.

The skua (Catharacta S. skua) is reportedly found only in the Lancaster Sound area of the eastern arctic. No nesting sites have been observed.

### 2.7.3 Anseriformes

Greater Snow Goose (Chen caerulescens atlantica)

Snow geese arrive in the study area each June. About 20,000 birds, representing one-third of the world's nesting population, nest on southwestern Bylot Island, while other scattered sites can be found around the shores of Eclipse Sound and northwestern Bylot Island. Geese nest in colonies located in low grassy tundra, broad shallow rivers, or on islands in shallow lakes. Rearing of the broods occurs in Navy Board Inlet and Eclipse Sound which are also important molting regions. Most of the geese leave the area by September (Figure 2.63).

Oldsquaw (Clangula hyemalis)

This species, a diving duck, requires shallow, coastal waters for feeding. It nests in tundra areas on many of the islands in the area (e.g., south coast region of Bylot Island). Pond Inlet and Eclipse Sound are important molting/feeding areas, as are the waters along the south coast of Devon Island and the east side of Bylot Island (Figure 2.64).

Spring migration begins in May, peaking in late June. Their distribution at this time is very dependant on ice conditions. In late July, molting begins and by mid-September, the fall migration has started, moving down the coast of Baffin Island.

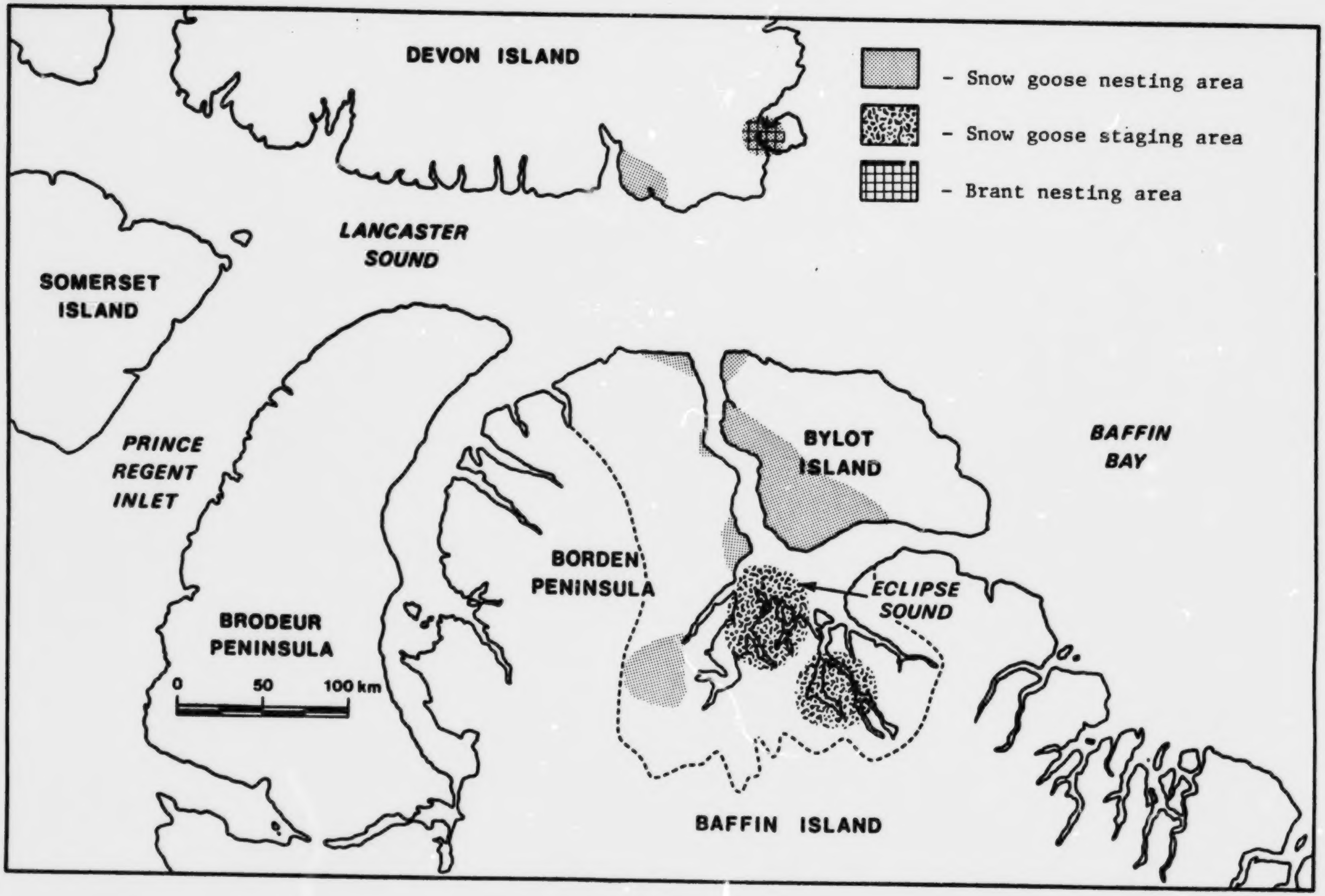

DEVON ISLAND
🟫 - Snow goose nesting area
▨ - Snow goose staging area
▦ - Brant nesting area
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.63** Distribution of greater snow goose and brant.

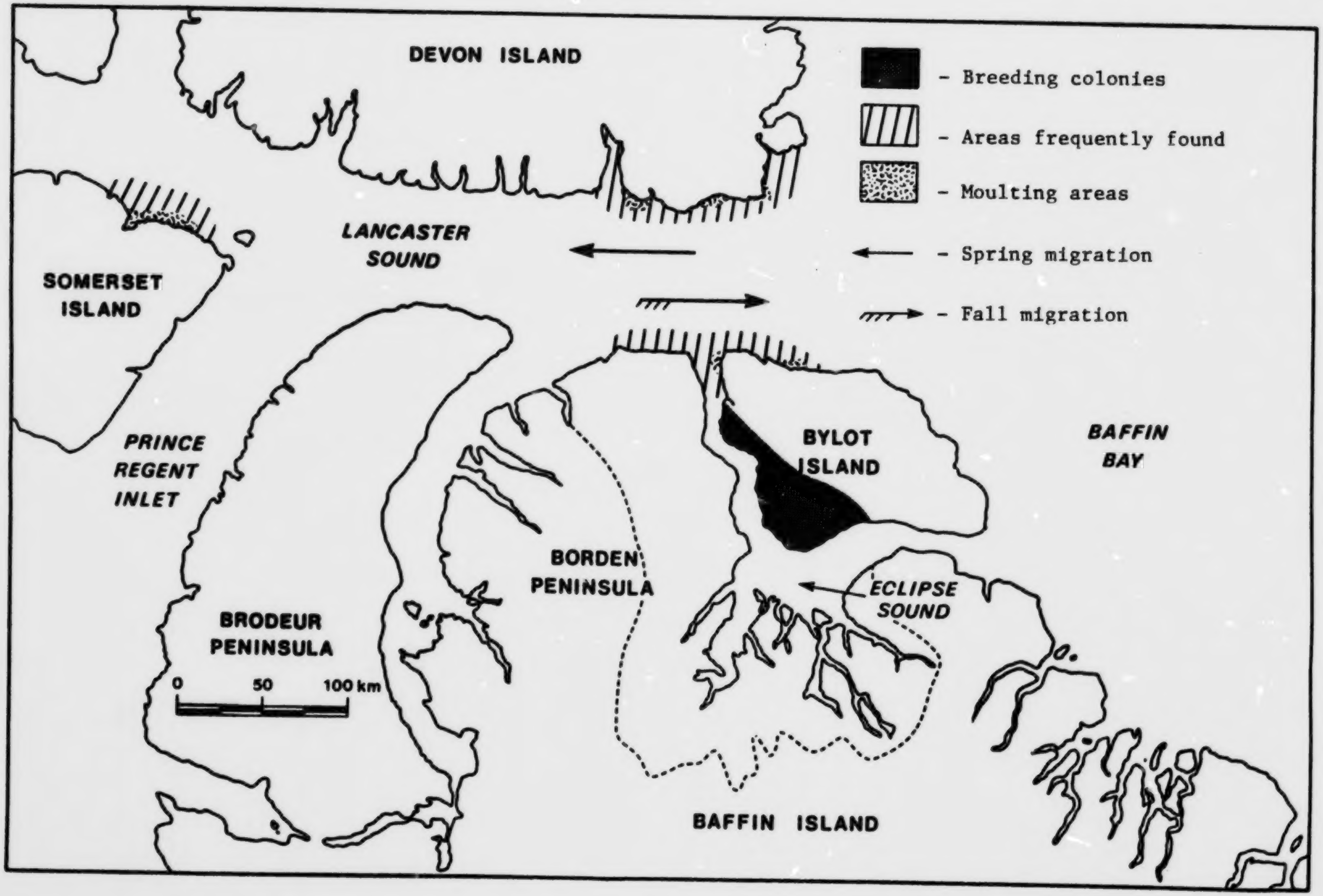

DEVON ISLAND
- Breeding colonies
- Areas frequently found
- Moulting areas
- Spring migration
- Fall migration
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BRODEUR PENINSULA
0
50
100 km
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
ECLIPSE SOUND
BAFFIN ISLAND

**Figure 2.64** Distribution of oldsquaw.

Eiders (Somateria spp.)

Both king (S. spectabilis) and common eiders (S. mollissima borealis) are widespread in the arctic. They are discussed collectively because during many surveys, especially from the air, it is difficult to distinguish between the two.

Spring migration begins in late April and the eiders follow the fast ice edge up the coast of Baffin Island. Most of the eiders which nest in the central and eastern portions of the arctic pass through Lancaster Sound (Figure 2.65).

King eider prefer coastal lowlands and southwestern Bylot Island is an important nesting area. Common eider prefer small coastal islands, but also nest solitarily at scattered coastal sites. Nesting occurs in late June and early July, when as many as 40,000 birds are present in the study area.

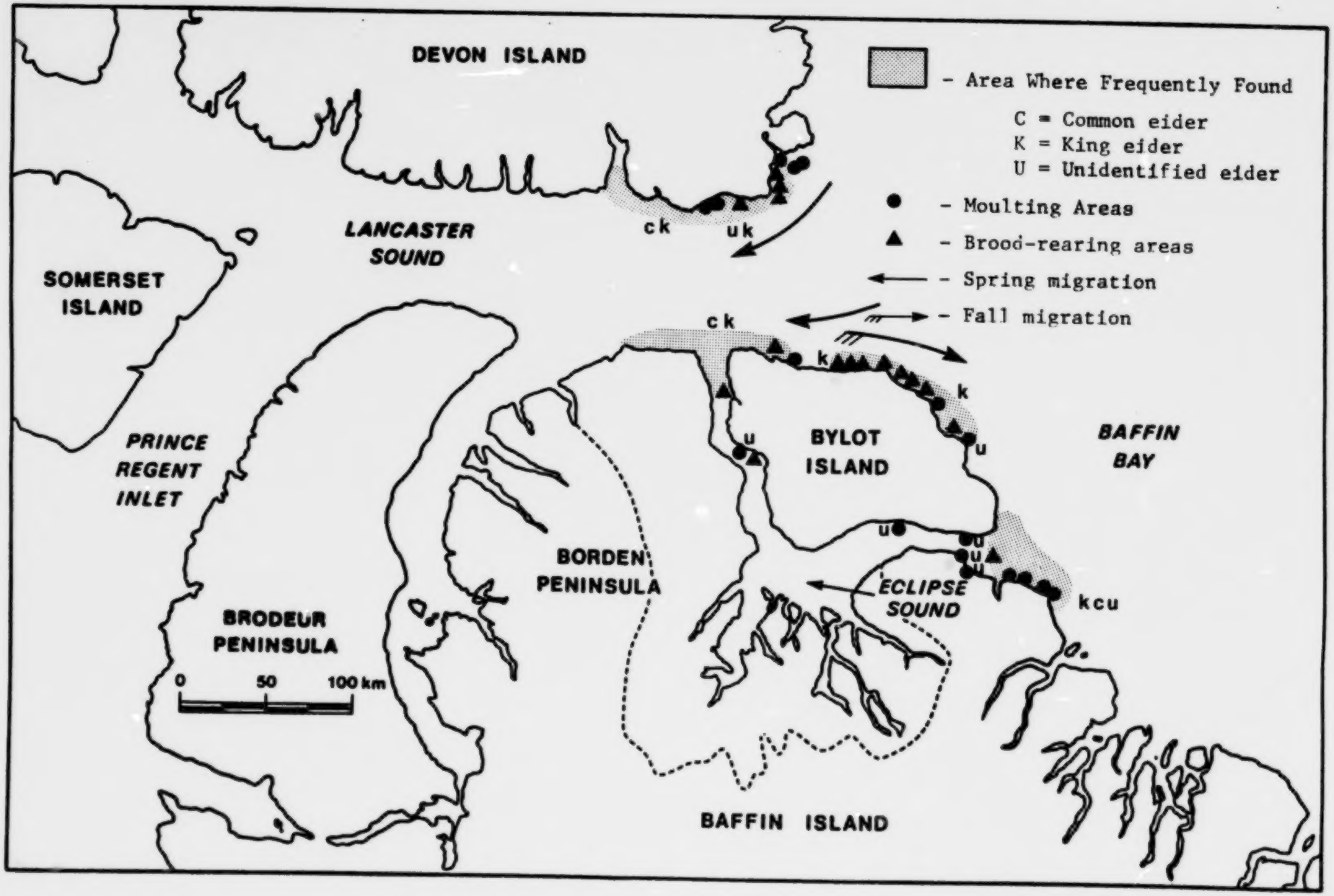
Molting begins in July and the north coast of Bylot Island and south coast of Devon Island are important gathering places. Fall migration begins in late September with most individuals moving south along the coast of Bylot Island and Baffin Island.

Canada Goose (Branta Canadiensis) and Brant Geese (B. bernicla)

The Canada goose (Branta canadensis) and brant (B. bernicla) are locally uncommon. Brant are sometimes found feeding along the edge of landfast ice and there is a nesting site on Philpots Island (Devon Island) (Figure 2.63).

### 2.7.4 Gaviiformes

The yellow-billed (Gavia adamsii) and arctic loons (G. arctica) are rare or casual visitors to eastern Lancaster Sound, although there are reports of a few nesting sites near Pond Inlet. Most of the population is found in the


DEVON ISLAND
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BRODEUR PENINSULA
BORDEN PENINSULA
BYLOT ISLAND
ECLIPSE SOUND
BAFFIN BAY
BAFFIN ISLAND
ck
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ck
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u
u
u
u
u
u
kcu
0
50
100 km
- Area Where Frequently Found
C = Common eider
K = King eider
U = Unidentified eider
● - Moulting Areas
▲ - Brood-rearing areas
- Spring migration
- Fall migration

**Figure 2.65** Distribution of eider ducks.

western arctic and high arctic islands. The red-throated loon (G. stellata) is more common. It nests on lowland ponds of major islands and the southwestern coast of Bylot Island is an important summering area (Figure 2.56).

### 2.7.5 Pelicaniformes

Two species of commorants, double-crested (Phalacrocorax auritus) and great (P. carbo), are rare visitors to the Lancaster Sound region, although common elsewhere.

## 2.8 MARINE MAMMALS

Lancaster Sound is an important staging area and corridor for many marine mammal species. These animals, migrating to regions north and west of the Sound, frequently feed heavily in the region. Beluga whales, narwhals, and bowhead whales occur in numbers large enough to have regional or national significance. For example, 35% of the Canadian population of belugas, 80% of the narwhals and most of the Eastern Canadian bowhead whales use the Lancaster Sound area annually. Narwhals are also known to summer/calve in Eclipse Sound. Polar bears, walrus, and several species of seals also are heavily dependant upon the region.

Detailed information on each species is presented in the following sections. The information has been summarized from a large number of reports (Finley et al, 1980, 1983, 1984; Finley and Gibb, 1982; Koski and Davis, 1979, 1980; R.R.C.S., 1977; Schweinsberg et al 1980, 1982; Smith et al, 1985) and from environmental impact statement reports (CMO, 1983; Lancaster Sound Regional Study, 1980a, 1980b; LGL, 1982, 1983; Norlands Petroleum Limited, 1978).

### 2.8.1 Polar Bears (Ursus maritimus)

Polar bears are circumpolar in distribution with about 1,000 individuals present in the Lancaster Sound area. Density is typical of the eastern arctic; however, the polar bear is considered an endangered species.

Polar bears are year-round residents, active in all seasons. The winter is spent offshore on the ice, preferentially landfast ice. They hunt along the fracture zones in the ice which are particularly common in northern Lancaster Sound.

The north coast of Bylot Island is an important wintering area. Denning occurs on land, between November and April and known areas include the north and east coasts of Bylot Island, northeast Brodeur Peninsula and southwest Devon Island. Southeastern Devon Island has not been adequately surveyed (Norlands Petroleums Limited, 1978).

Polar bears are present in the spring and summer along the north and west coasts of Bylot Island but as the ice disappears from Lancaster Sound, the bears move into the deep bays of inlets such as Navy Board Inlet and the bays of southern Devon Island, where ice remains. In the fall, they are present on the south and west coasts of Bylot Island, around Navy Board Inlet and Eclipse Sound.

Figure 2.66 shows the distribution of polar bears within the study area.

### 2.8.2 Harp Seal (Phoca groenlandica)

Of the three distinct stocks of harp seals, only one (western Atlantic) which whelps and molts on the pack ice near Newfoundland, migrates to the Canadian arctic region (LGL, 1982). Population estimates vary, but recent estimates are that the western Atlantic stock numbers about 1,250,000. A significant portion, up to 1,000,000, migrate north into Lancaster Sound in the summer.

In the arctic, harp seals are generally found in small groups of less than 20 individuals. They tend to be widely distributed and no recurring site-specific concentrations are known.

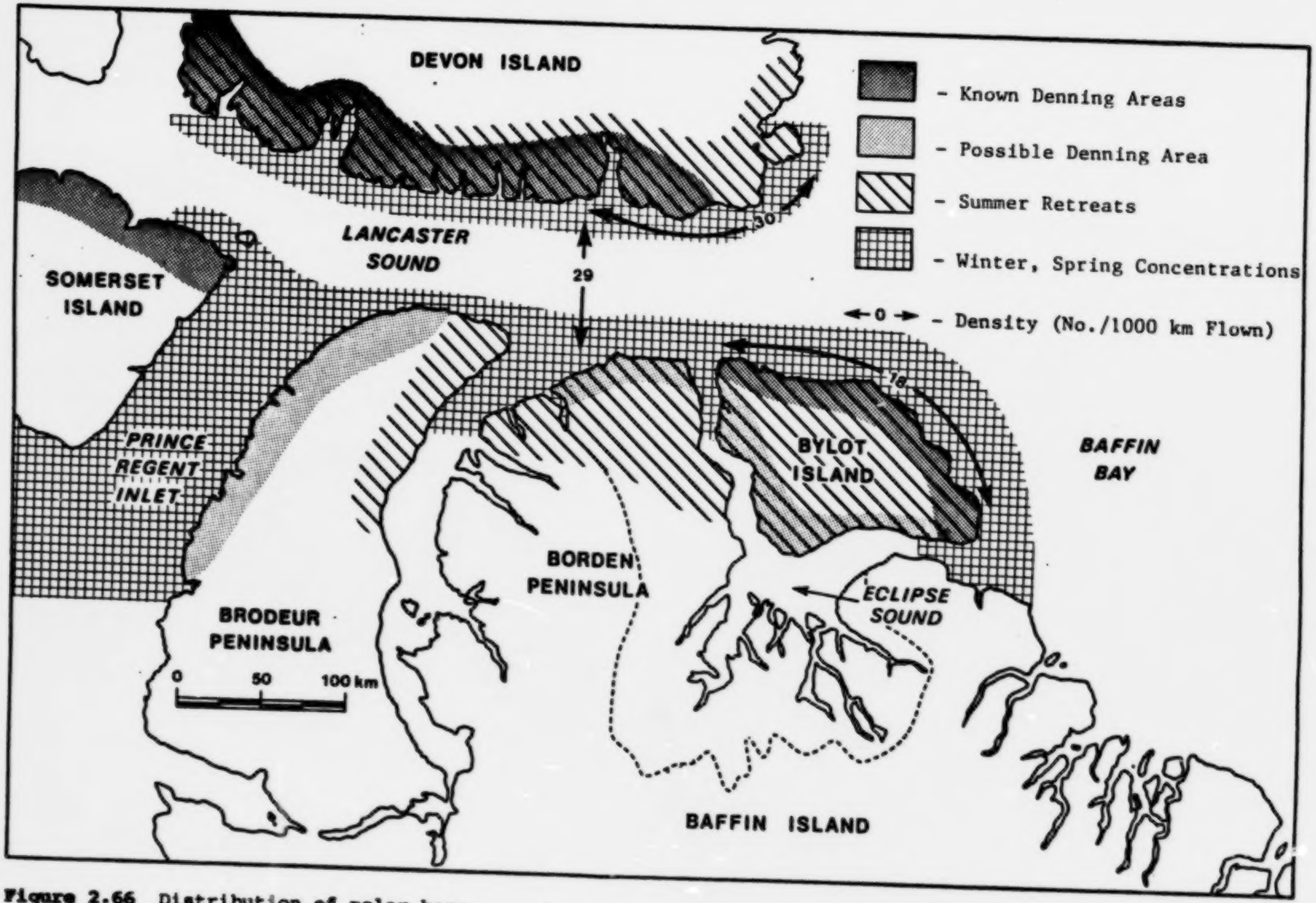

DEVON ISLAND
- Known Denning Areas
- Possible Denning Area
- Summer Retreats
- Winter, Spring Concentrations
0
- Density (No./1000 km Flown)
30
LANCASTER SOUND
29
SOMERSET ISLAND
18
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

Figure 2.66 Distribution of polar bear.

Harp seals migrate into Lancaster Sound between June and August, following the ice edge along eastern Bylot Island; many are observed from Cape Hay, along the ice edge in Navy Board Inlet, and in the southern portion of Lancaster Sound. A few enter Pond Inlet/Eclipse Sound/Navy Board Inlet (Figure 2.67).

The fall migration starts in late September and October, and many of the seals retrace their paths along Bylot Island and Baffin Island. Others, however, cross Lancaster Sound and follow the southern coast Devon Island.

### 2.8.3 Bearded Seal (Erignathus barbatus)

Bearded seals are solitary and widely distributed throughout the arctic. They prefer moving pack ice and generally avoid fast ice or close pack ice. They are present in Lancaster Sound between May and October, migrating along the northern shore of Bylot Island from offshore. During the ice-free period, they are generally found along the coast. They have been seen to enter Pond Inlet and Navy Board Inlet as the ice recedes.

While the highest densities of bearded seals can be found in Lancaster Sound, the numbers are still low, between 100 and 200 individuals of the estimated 75,000 to 100,000 that are thought to inhabit the Baffin Island and Greenland coastline. They feed primarily on benthic invertebrates and arctic cod and depend on shallow coastal waters with high benthic productivity.

During July there is an apparent westward movement through Lancaster Sound, possibly to Viscount Melville Sound and an eastward migration during late September and October (Figure 2.68).

### 2.8.4 Harbour Seal (Phoca vitulina concolor)

The harbour seal is sparsely and locally distributed in the Canadian arctic. There have been records from the eastern coast of Baffin Island

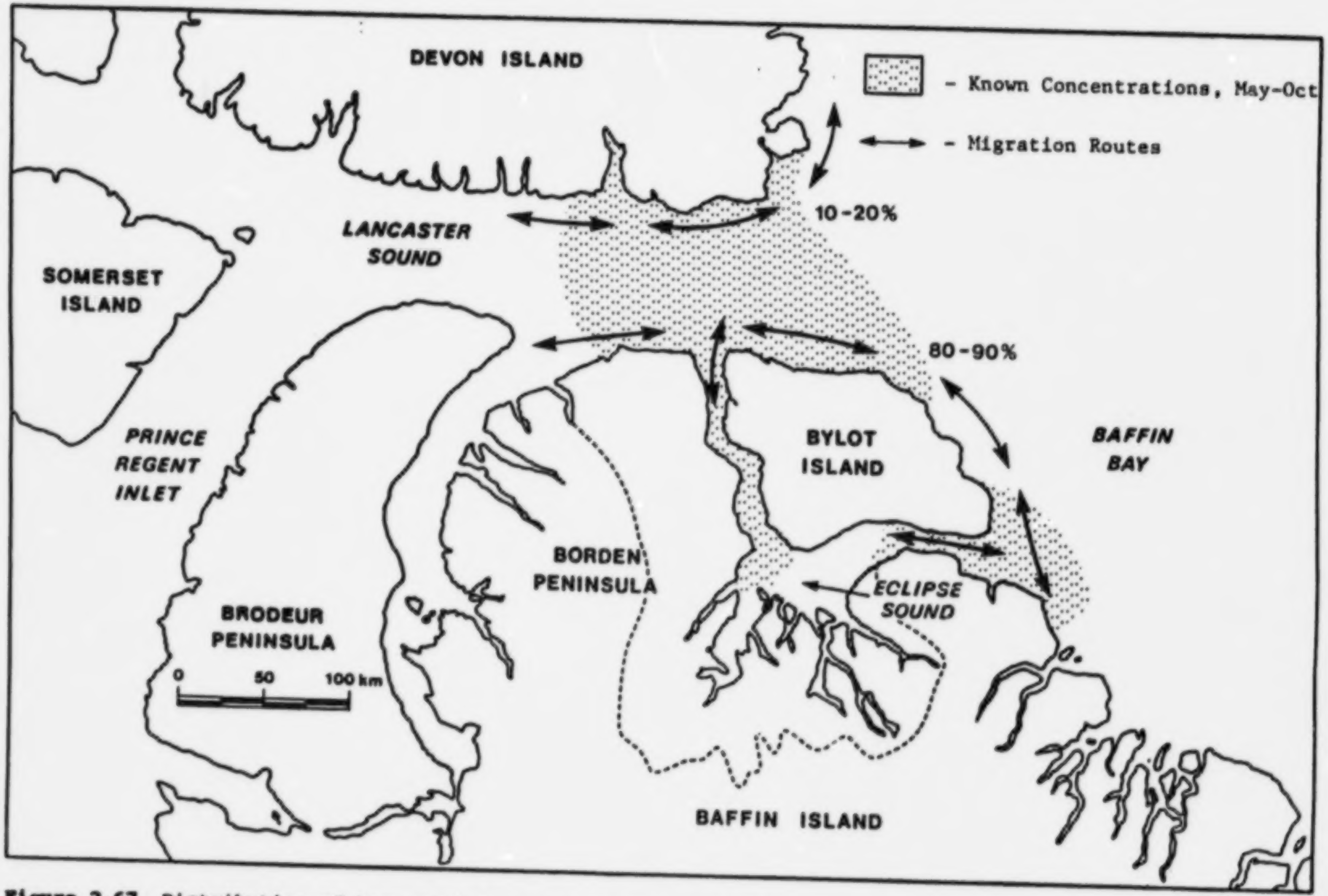

DEVON ISLAND
- Known Concentrations, May-Oct
- Migration Routes
LANCASTER SOUND
10-20%
SOMERSET ISLAND
80-90%
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

Figure 2.67 Distribution of harp seal (percentage figures indicate relative proportion of total migration.)

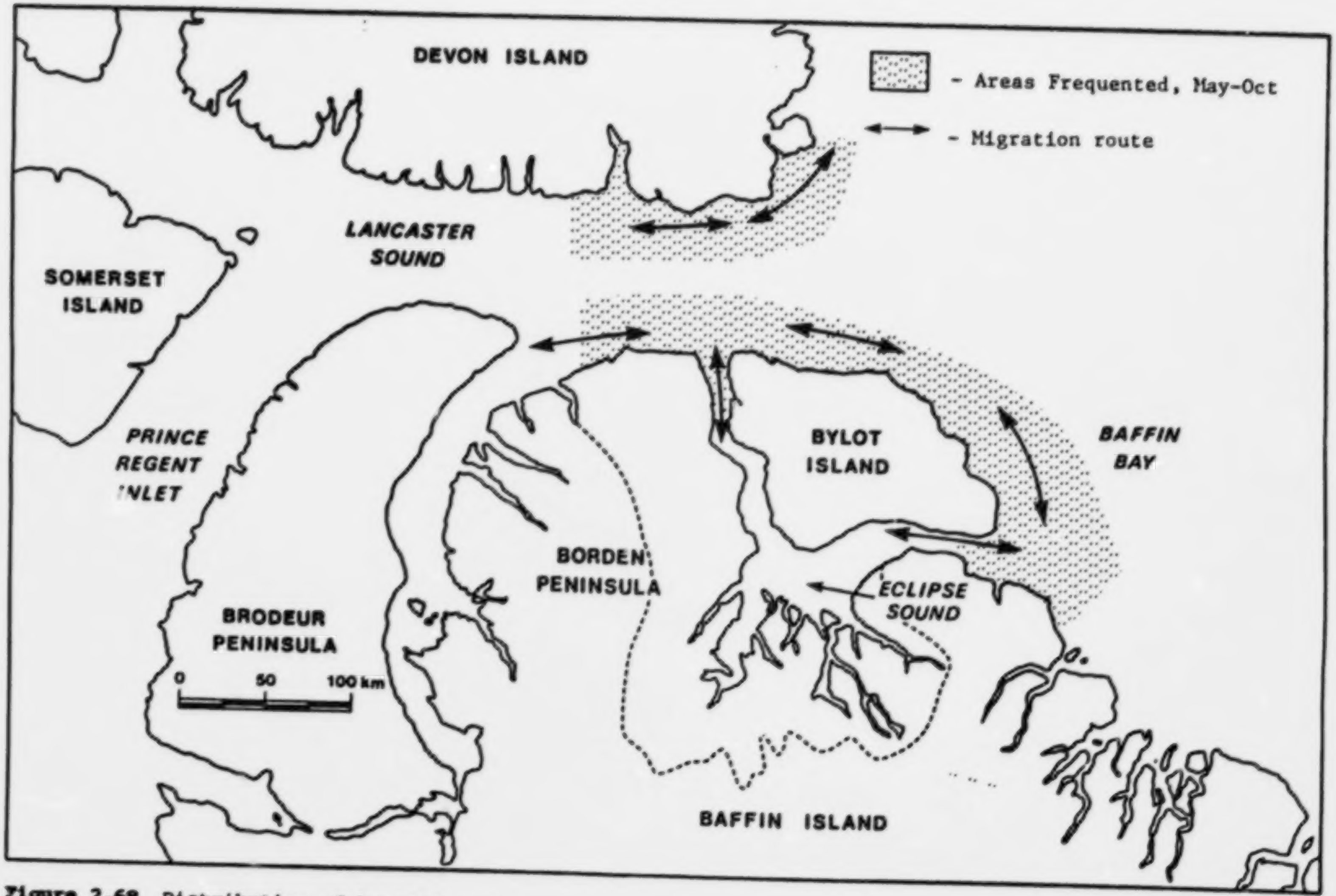

DEVON ISLAND
- Areas Frequented, May-Oct
- Migration route
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

Figure 2.68 Distribution of bearded seal.

and Pond Inlet (Norlands Petroleum Limited, 1978). None were reported during the aerial surveys carried out between 1975 and 1979 although it is very difficult to distinguish harbour seals from the ringed seal from the air (LGL, 1982).

### 2.8.5 Hooded Seal (*Cystophera cristata*)

Hooded seals are closely associated with heavy pack or drift ice in the offshore waters of Davis Strait. A proportion of the population moves north into Baffin Bay and Lancaster Sound in the summer. Numbers recorded are very low. It is assumed that they migrate south again in the fall to offshore Davis Strait.

### 2.8.6 Ringed Seal (*Phoca hispida*)

The ringed seal is among the most abundant and widespread of mammals in the arctic. It is a permanent resident with an estimated population of about 100,000 in Lancaster Sound. However, the densities there are lower than in Baffin Bay where over 400,000 ringed seals occur.

Ringed seals are common on pack ice, where breathing holes are maintained over winter. A smaller number can be found along the fast ice. They feed primarily on crustaceans and arctic cod. They in turn are harvested extensively by polar bears and by the Inuit.

Ringed seals whelp in late March on ice flows in Baffin Bay and Lancaster Sound. There is also some reproduction in Navy Board Inlet, Eclipse Sound and Pond Inlet on the fast ice.

Figure 2.69 shows the general distribution of ringed seals within the study area.

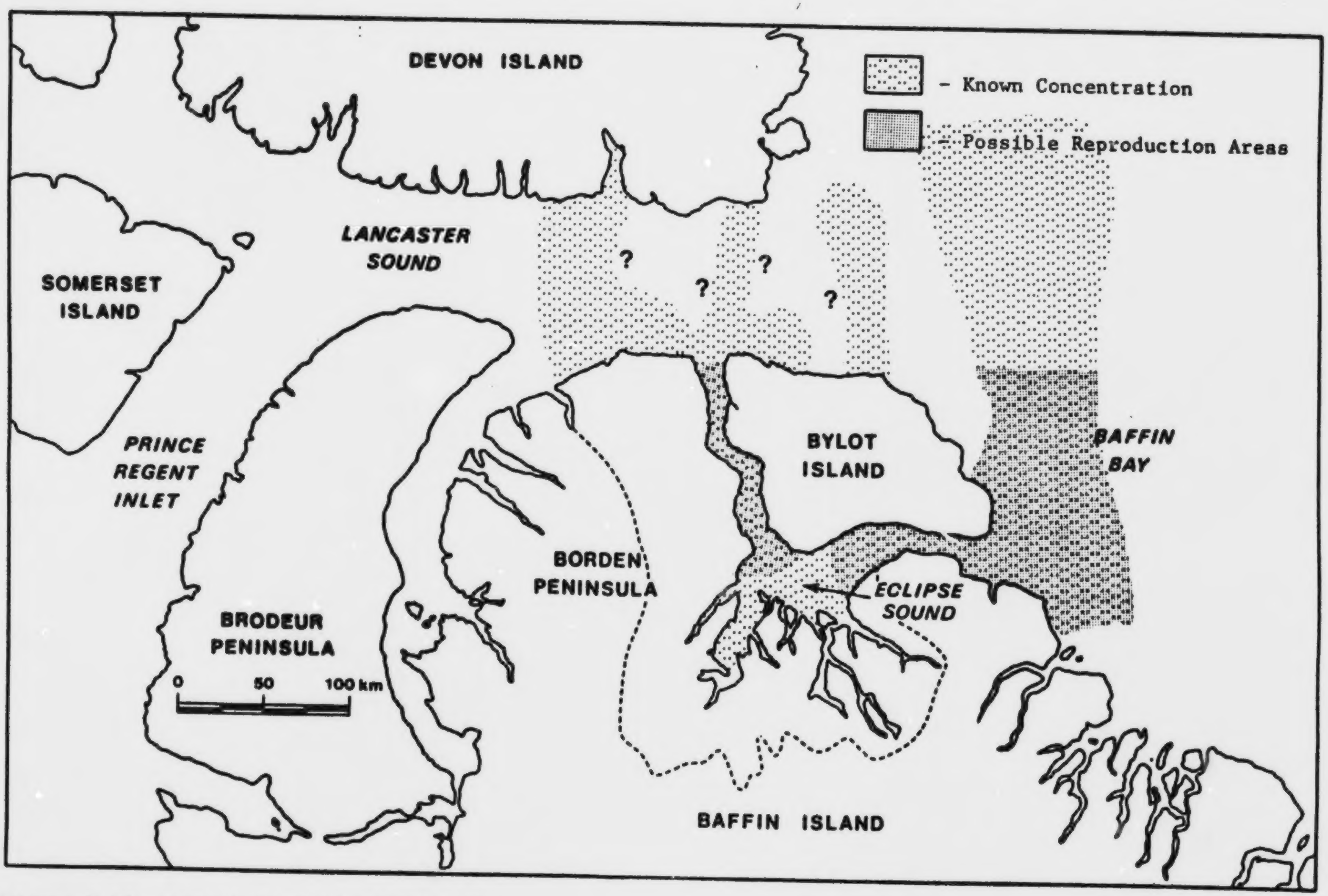

DEVON ISLAND
- Known Concentration
- Possible Reproduction Areas
LANCASTER SOUND
SOMERSET ISLAND
?
?
?
?
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.69** Distribution of ringed seal.

### 2.8.7 Walrus (Odobenus rosmarus)

Walrus enter Lancaster Sound during the summer, mostly along the south coast of Devon Island. These animals may be migrants from wintering areas off southern Ellesmere Island or may originate from the west Greenland coast. Distribution and abundance of these mammals is not well-known but an estimated 1,000 individuals are thought to utilize Lancaster Sound. Croker Bay and Philpots Island (Devon Island) are major summer areas. Walrus have also been observed at Cape Hay, Bylot Island, and Wollaston Island, near the entrance of Navy Board Inlet. Wollaston Island and Cape Crauford, Brodeur Peninsula are also believed to be major haul-out areas (Figure 2.70).

Walrus feed near their haul-out areas, with benthic invertebrates, especially molluscs, being their main diet. They generally do not move too far from the coast.

Walrus do not overwinter in Lancaster Sound and the fall migration begins at freezeup in early October, retracing their path along the coast of Devon Island to open water areas northwest of Lancaster Sound.

### 2.8.8 Beluga Whale (Delphinapterus leucas)

Beluga whales migrate through Lancaster Sound on their way to inlets further west off Somerset Island and Brodeur Peninsula. Peak movement is in June and July but is strongly influenced by ice and fast ice leads. Most of the whales (80%) move along the south shore of Devon Island, the remainder following the coast of Bylot Island. About 35% of the world population of 30,000 belugas utilize Lancaster Sound. A few have been observed in Pond Inlet and Navy Board Inlet during summer. Many also summer in the bays along the south coast of Devon Island, such as Radstock Bay.

Belugas are a social species and often occur in large pods. They feed mostly on arctic cod, along the ice edges and ice leads. Fall migration is

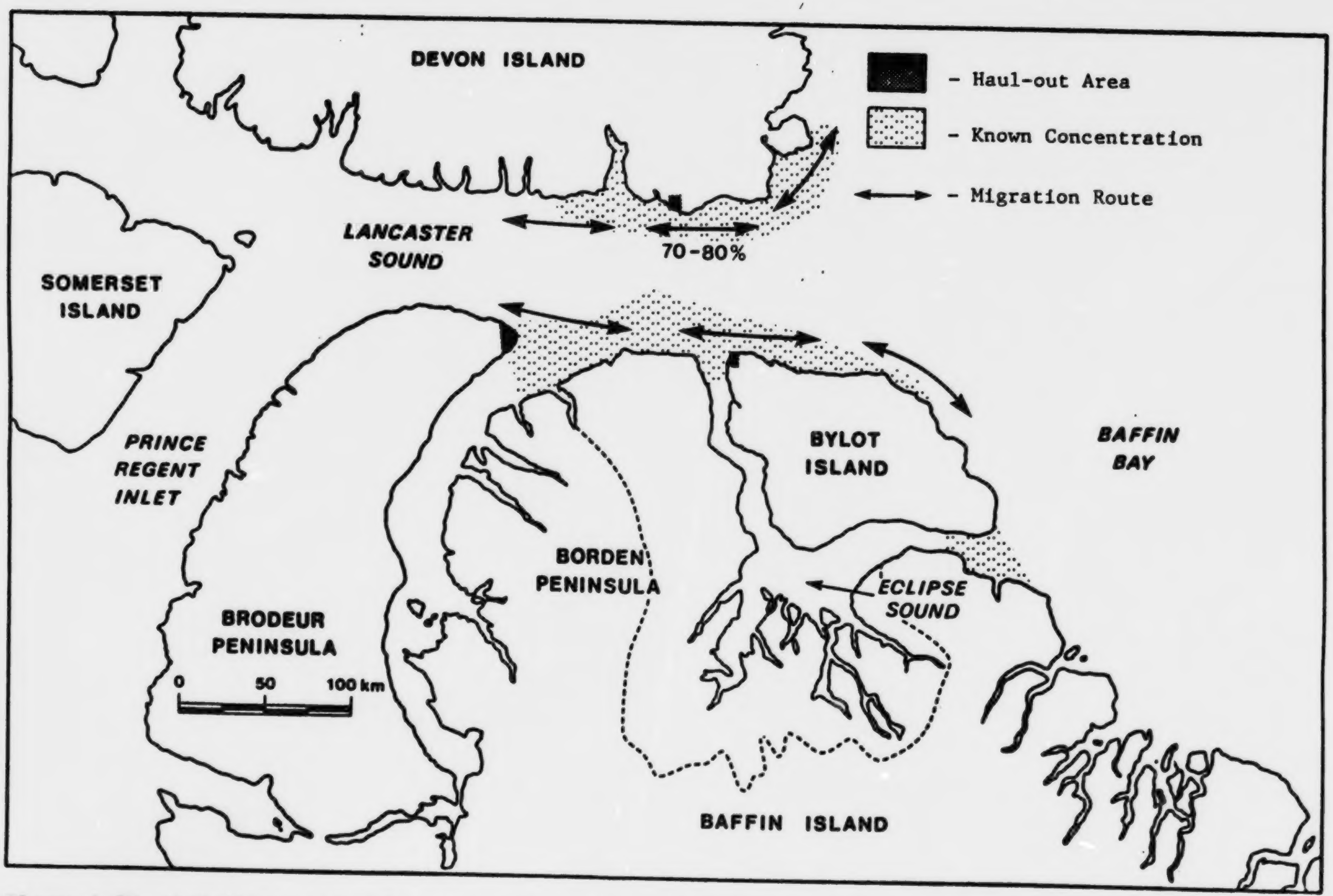

DEVON ISLAND
▇ - Haul-out Area
▨ - Known Concentration
↔ - Migration Route
LANCASTER SOUND
70-80%
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.70** Distribution of walrus (percentage figures indicate relative proportion of total migration.)

much more rapid than the spring and occurs during September. Most move along the coast of Devon Island and head north towards Jones Sound and west Greenland coast. Some may over-winter in the 'North Water' of northern Baffin Bay (Figure 2.71).

### 2.8.9 Narwhal (Monodon monoceros)

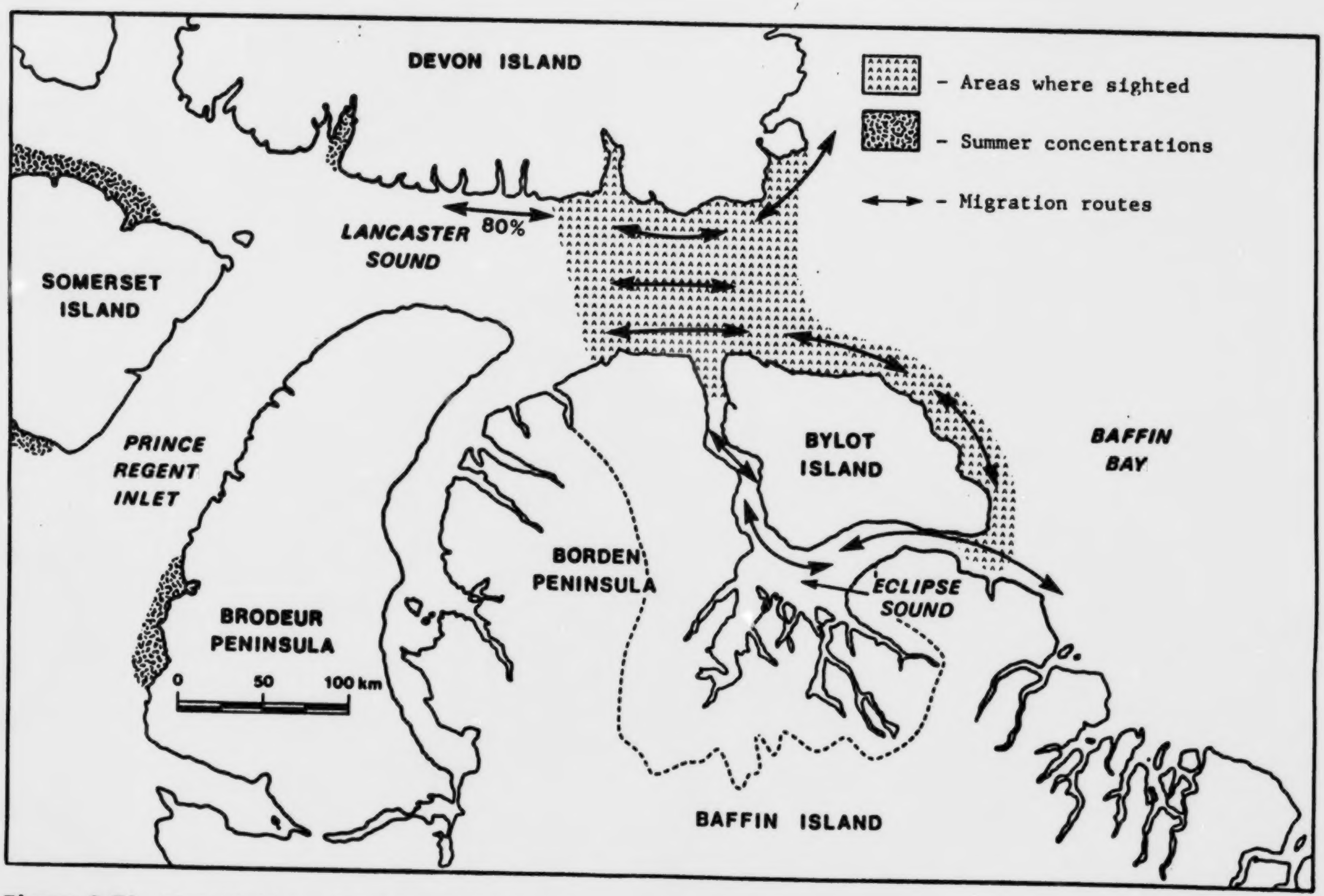
Narwhals winter in the close pack ice of Davis Strait and follow the fast ice edge into the Lancaster Sound region in June and July. About 25-30,000 are believed to move through the region, with 2,000-4,000 utilizing Navy Board Inlet, Eclipse Sound and Milne Inlet areas, believed to be traditional calving areas. Another known nursing area is Admiralty Inlet (Figure 2.72).

It is estimated that 80% of the world narwhal population passes through Lancaster Sound. Roughly equal numbers (21%) follow the north and south coastlines but most (57%) move through the central sound (> 7 km from the coast). They summer in the deep water fjords of the arctic, such as Eclipse Sound and Kolukloo Bay, and begin their fall migration in September. By the end of September, large numbers are found in Lancaster Sound from where they move out to Baffin Bay along both the north and south shores of the Sound, and offshore to Baffin Bay.

Narwhals feed on shrimp, squid and fish, with arctic cod making up over half the diet. Greenland halibut, redfish and polar cod have also been found in narwhal stomachs. While they feed intensively along ice edges, there appears to be little activity in late summmer and traditional summer areas are believed to be more related to calving requirements than feeding opportunities.

### 2.8.10 Killer Whale (Orcinus orca)

Killer whales are occasionally seen in small numbers (10-20) in Pond Inlet and Navy Board Inlet during the open water period; some also enter Eclipse Sound and southern Milne Inlet, where they prey on narwhal. During the summer of 1985 a pod of killer whales was observed harrassing a head of approximately 500 narwhal in Koluktoo Bay, Southern Milne Inlet (Yurick, pers. comm., 1986); such occurrences had previously been reported in Steltner et al. (1984). They likely migrate from the area as freezeup commences (Figure 2.73).



DEVON ISLAND
- Areas where sighted
- Summer concentrations
- Migration routes
LANCASTER SOUND
80%
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.71** Distribution of beluga whale (percentage figures indicate relative proportion of total migration.)

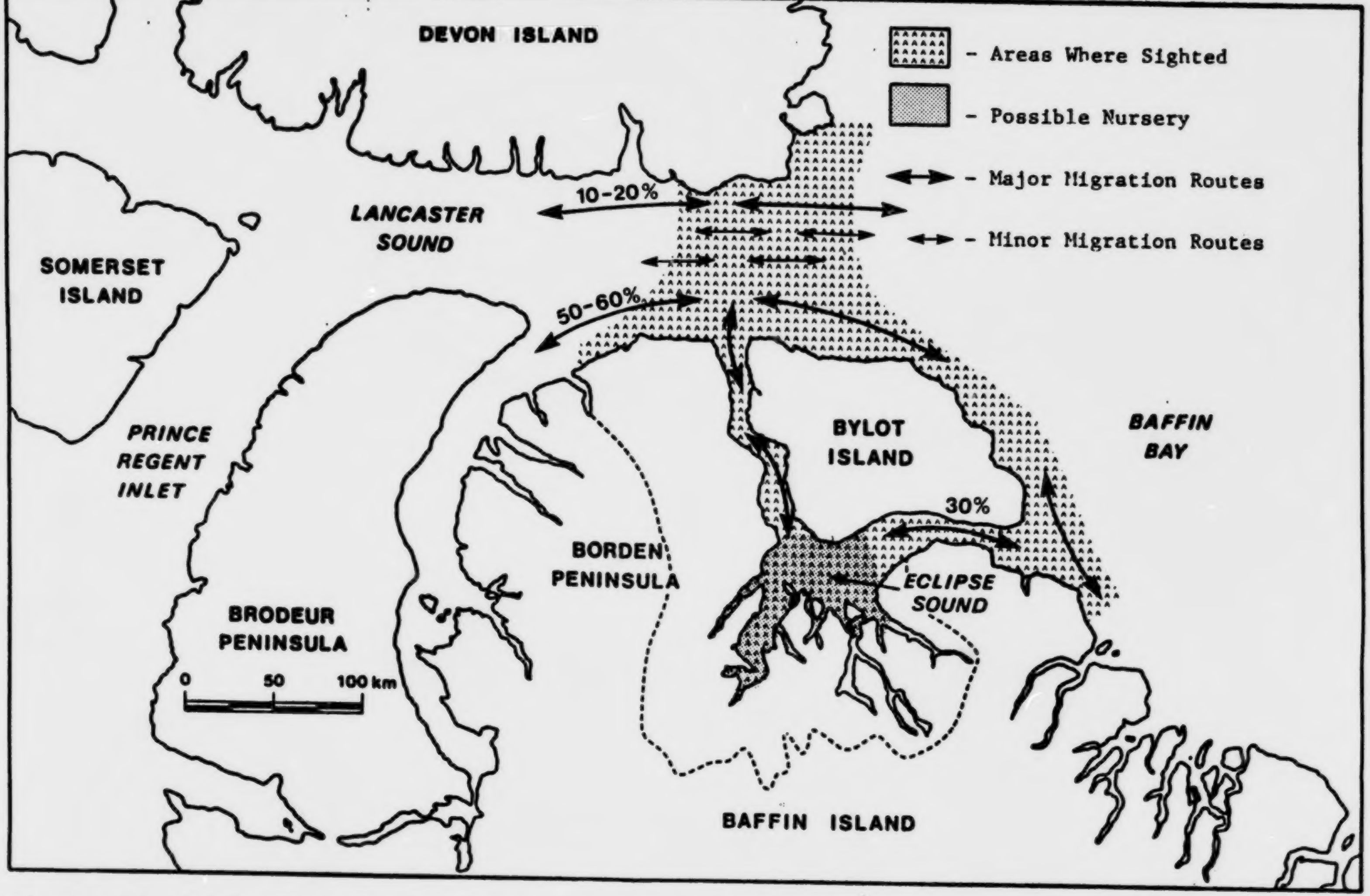

DEVON ISLAND
SOMERSET ISLAND
LANCASTER SOUND
PRINCE REGENT INLET
BRODEUR PENINSULA
BORDEN PENINSULA
BYLOT ISLAND
ECLIPSE SOUND
BAFFIN ISLAND
BAFFIN BAY
10-20%
50-60%
30%
- Areas Where Sighted
- Possible Nursery
- Major Migration Routes
- Minor Migration Routes
0
50
100 km

**Figure 2.72** Distribution of narwhal (percentage figures indicate relative proportion of total migration.)

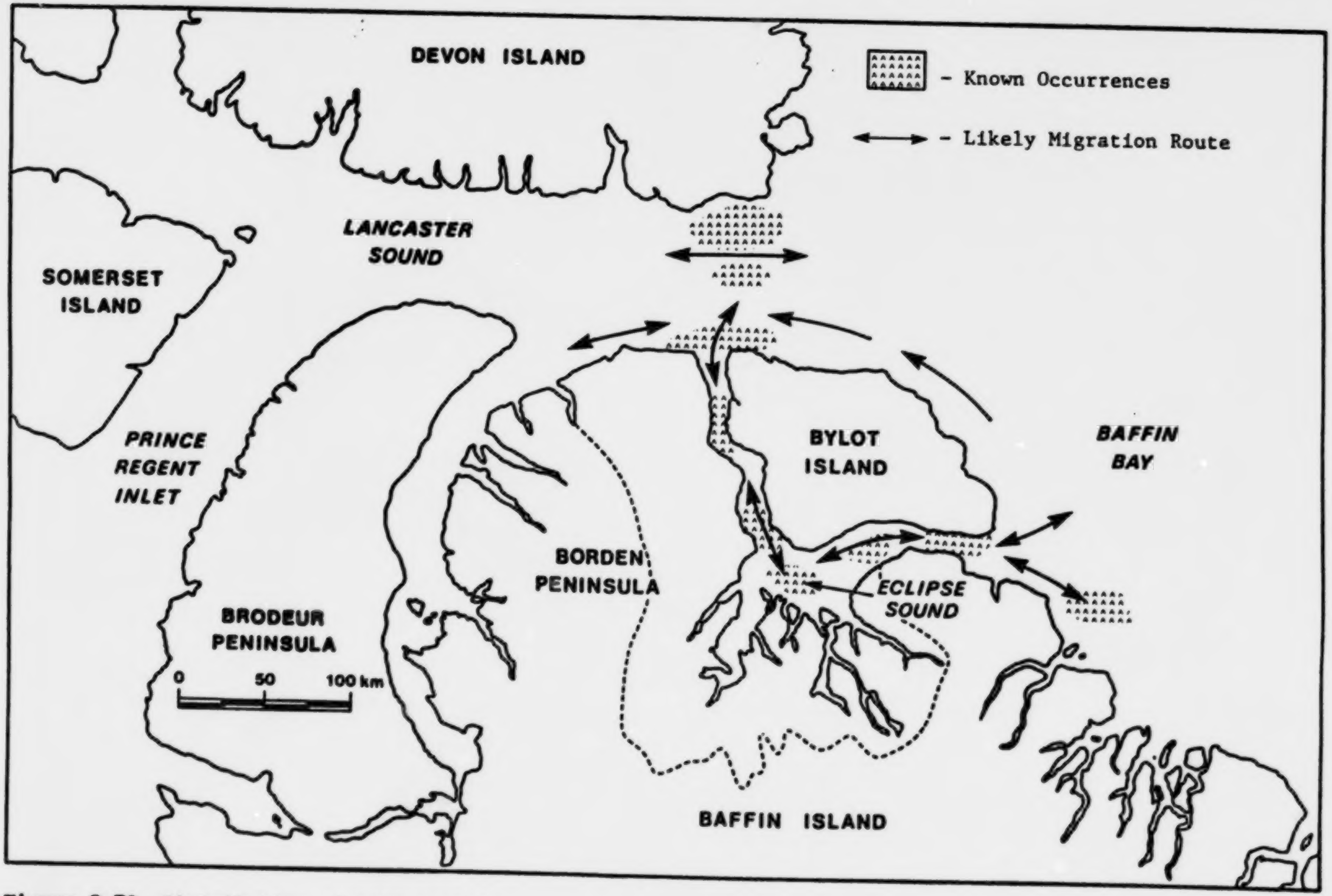

DEVON ISLAND
- Known Occurrences
- Likely Migration Route
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.73** Distribution of killer whale.

### 2.8.11 Bowhead Whale (Balaena mysticetus)

The bowhead is considered an endangered species with the total population of the Baffin Bay - Davis Strait stock being only a few hundred. Historically, large numbers were found in the vicinity of Pond Inlet and Eclipse Sound (Figure 2.74) but have declined due to whaling activities around the turn of the century.

The spring migration through Lancaster Sound is primarily offshore, between May and mid-August. Bowheads move as far west as Barrow Strait. In August, they move into summering areas in Prince Regent Inlet, Admiralty Inlet, Eclipse Sound and Navy Board Inlet. Isabella Bay along the east coast of Baffin Island has been identified as one of the most important summering areas in the eastern Arctic. Fall migration begins in late September and is completed by October, moving along the south side of Lancaster Sound, following the coast of Bylot Island to wintering areas off Greenland, Cumberland Sound and waters further south.

The bowheads are baleen whales, feeding on planktonic copepods and pteropods. In historic times, the bowhead was a more ecologically significant species, consuming one and a half times as much food as all other eastern arctic mammals and seabirds combined. The decline in the population has resulted in a shift in the energy flow of the region, with a larger proportion of the total energy consumed by birds and mammals coming from arctic cod, instead of directly from the primary producers.

## 2.9 MARINE PLANTS

One hundred and seventy-five species of marine plants (macroalgae) have been reported from the arctic. Table 2.5 lists the dominant ones from the region (Lee, 1980). Macroalgae are restricted to nearshore areas where sufficient light can reach the bottom, although ice scouring generally prevents much intertidal growth. Algae also require hard substrates and such rocky areas are common around Lancaster Sound. Thomson and Cross

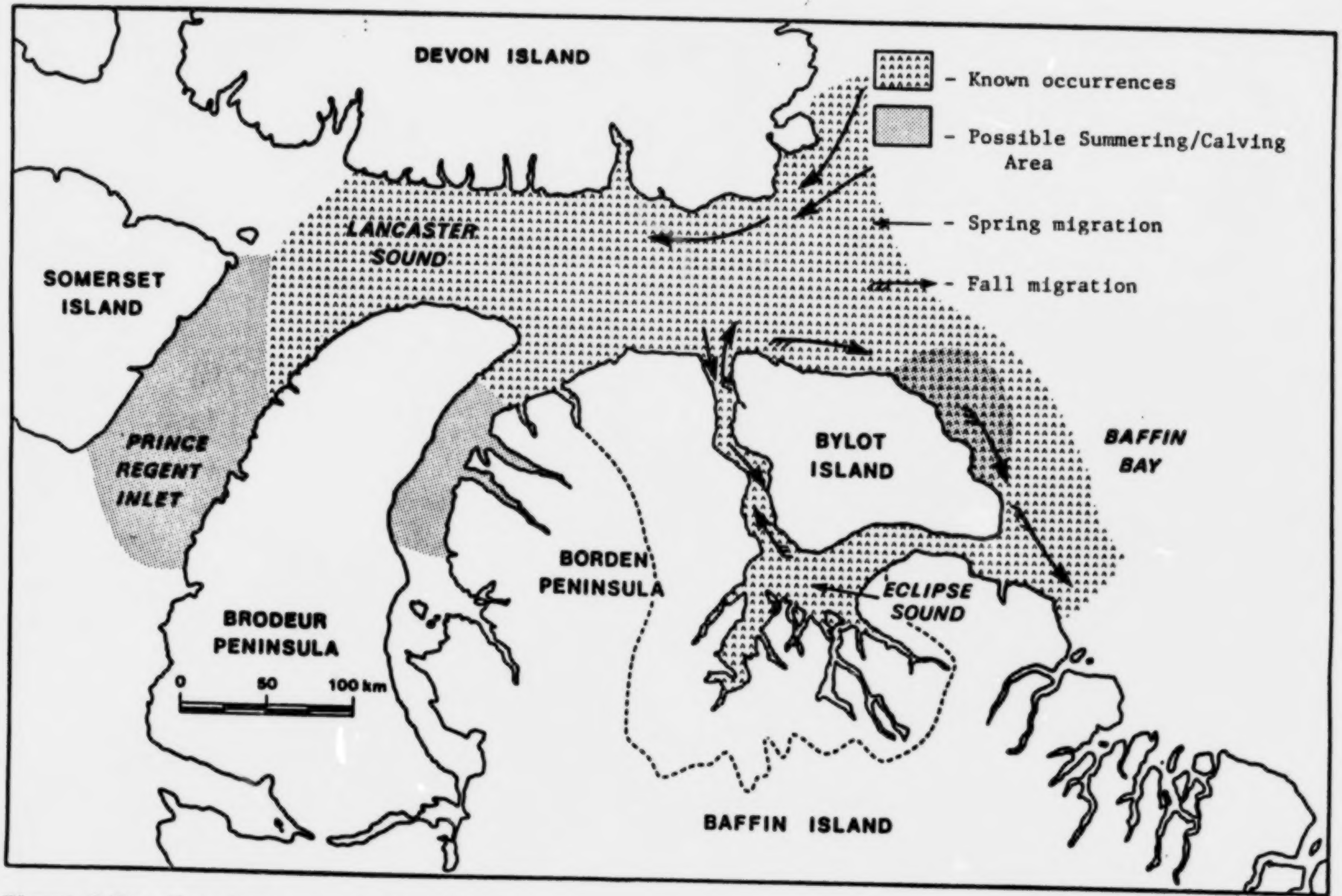

DEVON ISLAND
▦ - Known occurrences
▨ - Possible Summering/Calving Area
→ - Spring migration
→ - Fall migration
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.74** Distribution of bowhead whale.

### Table 2.5 Major Macroalgal Species Recorded from Arctic Waters (from Lee,1980).

The following is a checklist of the species catalogued. Those in boldface are new records.

- CHLOROPHYCEAE
- Volvocales
  - Palmellaceae
    - *Gloeocystis*
      - *scopulorum* Hansgirg

- Chlorococcales
  - Characiaceae
    - *Codiolum*
      - *gregarium* A. Braun
      - *pusillum* (Lyngbye) Kjellman
  - Endosphaeraceae
    - *Chlorochytrium*
      - *dermatocolax* Reinke
      - *inclusum* Kjellman
      - *schmitzii* Rosenvinge
    - *Gomontia*
      - *polyrhiza* (Lagerheim) Bornet and Flahault
  - Phyllosiphonaceae
    - *Ostreobium*
      - *quekettii* Bornet and Flahault

- Prasiolales
  - Prasiolaceae
    - *Prasiola*
      - *johanseni* Collins
    - *Rosenvingiella*
      - *polyrhiza* (Rosenvinge) Silva

- Ulotrichales
  - Ulotrichaceae
    - *Ulothrix*
      - *flacca* (Dillwyn) Thuret
      - *laetevirens* (Hooker) Collins
      - *pseudoflacca* Wille
      - *subflaccida* Wille

- Ulvales
  - Capsosiphonaceae
    - *Capsosiphon*
      - ***fulvescens*** (C. Agardh) Setchell and Gardner
  - Percursariaceae
    - *Percursaria*
      - *percursa* (C. Agardh) Rosenvinge
- Monostromataceae
  - *Blidingia*
    - *marginata* (J. Agardh) P. Dangeard
      - subsp. *marginata*
      - subsp. ***subsala*** (Kjellman) Bliding
    - *minima* (Nägeli) Kylin
      - var. *minima*
      - var. *ramifera* Bliding
  - *Kornmannia*
    - *leptoderma* (Kjellman) Bliding
  - *Monostroma*
    - *arcticum* Wittrock
- Ulvaceae
  - *Enteromorpha*
    - *clathrata* (Roth) Greville
    - *compressa* (Linnaeus) Greville
    - *crinita* (Roth) J. Agardh
    - *flexuosa* (Wulfen) J. Agardh
      - subsp. *paradoxa* (Dillwyn) Bliding
    - *groenlandica* (J. Agardh) Setchell and Gardner
    - *intestinalis* (Linnaeus) Link
    - *linza* (Linnaeus) J. Agardh
    - *prolifera* (O. F. Müller) J. Agardh
  - *Ulva*
    - *lactuca* Linnaeus
    - *rigida* C. Agardh
  - *Ulvaria*
    - *obscura* (Kützing) Gayral
      - var. *blyttii* (Areschoug) Bliding
    - ***oxysperma*** (Kützing) Bliding

- Chaetophorales
  - Chaetophoraceae
    - *Acrochaete*
      - *repens* Pringsheim
    - *Arthrochaete*
      - ***penetrans*** Rosenvinge
    - *Bolbocoleon*
      - *piliferum* Pringsheim
    - *Chaetobolus*
      - *gibbus* Rosenvinge
    - *Ectochaete*
      - ***leptochaete*** (Huber) Wille
      - ***wittrockii*** (Wille) Kylin
    - *Entocladia*
      - *viridis* Reinke
    - *Epicladia*
      - *flustrae* Reinke
    - *Pringsheimiella*
      - *scutata* (Reinke) Marchewianka
    - *Pseudendoclonium*
      - *submarinum* Wille
    - *Pseudopringsheimia*
      - ***confluens*** (Rosenvinge) Wille
      - ***fucicola*** (Rosenvinge) Wille
  - Chroolepidaceae
    - *Pilinia*
      - ***endophytica*** Collins

- Acrosiphoniales
  - Acrosiphoniaceae
    - *Urospora*

**Table 2.5 (cont'd)**

- *mirabilis* Areschoug
- *wormskjoldii* (Mertens) Rosenvinge
- *Acrosiphonia*
  - *arcta* (Dillwyn) J. Agardh
  - *hystrix* (Strömfelt) Jónsson
- *Spongomorpha*
  - *aeruginosa* (Linnaeus) Hoek

- Cladophorales
  - Cladophoraceae
    - *Rhizoclonium*
      - *riparium* (Roth) Harvey
    - *Chaetomorpha*
      - *linum* (O. F. Müller) Kützing
      - *melagonium* (Weber and Mohr) Kützing
    - *Cladophora*
      - *sericea* (Hudson) Kützing
      - *sp.*

- PHAEOPHYCEAE
- Ectocarpales
  - Ectocarpaceae
    - *Pilayella*
      - *littoralis* (Linnaeus) Kjellman
    - *Ectocarpus*
      - *fasciculatus* Harvey
      - *siliculosus* (Dillwyn) Lyngbye
    - *Giffordia*
      - *ovata* (Kjellman) Kylin
    - *Laminariocolax*
      - *tomentosoides* (Farlow) Kylin
    - *Streblonema*
      - *stilophorae* (Crouan and Crouan) Hamel
    - *Kolderupia*
      - *maritima* (Kjellman) S. Lund
    - *Phaeostroma*
      - *parasiticum* Børgesen
      - *pustulosum* Kuckuck
  - Ralfsiaceae
    - *Symphyocarpus*
      - *strangulans* Rosenvinge
    - *Ralfsia*
      - *clavata* (Harvey) Crouan and Crouan
      - *fungiformis* (Gunner) Setchell and Gardner
      - *ovata* Rosenvinge
      - *verrucosa* (Areschoug) J. Agardh
    - *Sorapion*
      - *kjellmanii* (Wille) Rosenvinge
    - *Lithoderma*
      - *fasticens* Areschoug
    - *Pseudolithoderma*
      - *extensum* (Crouan and Crouan) S. Lund
      - *rosenvingii* (Waern) S. Lund
      - *subextensum* (Waern) S. Lund

- Sphacelariales
  - Sphacelariaceae
    - *Sphacelaria*
      - *arctica* Harvey
      - *cirrosa* (Roth) C. Agardh
      - *plumosa* Lyngbye
      - *radicans* (Dillwyn) C. Agardh

- Tilopteridales
  - Tilopteridaceae
    - *Haplospora*
      - *globosa* Kjellman

- Chordariales
  - Myrionemataceae
    - *Dermatocelis*
      - *laminariae* Rosenvinge
    - *Hecatonema*
      - *foecundum* (Strömfelt) Loiseaux
      - *maculans* (Collins) Sauvageau
    - *Leptonematella*
      - *fasciculata* (Reinke) Silva
    - *Microsporangium*
      - *globosum* Reinke
    - *Myrionema*
      - *aecidioides* (Rosenvinge) Sauvageau
      - *strangulans* Greville
  - Elachistaceae
    - *Elachista*
      - *fucicola* (Velley) Areschoug
  - Chordariaceae
    - *Eudesme*
      - *virescens* (Carmichael) J. Agardh
    - *Chordaria*
      - *flagelliformis* (O. F. Müller) C. Agardh

- Desmarestiales
  - Desmarestiaceae
    - *Desmarestia*
      - *aculeata* (Linnaeus) Lamouroux
      - *viridis* (O. F. Müller) Lamouroux

- Dictyosiphonales
  - Striariaceae
    - *Isthmoplea*
      - *sphaerophora* (Carmichael) Kjellman
    - *Stictyosiphon*
      - *tortilis* (Ruprecht) Reinke
  - Punctariaceae
    - *Litosiphon*
      - *filiformis* (Reinke) Batters
    - *Desmotrichum*
      - *undulatum* (J. Agardh) Reinke
    - *Punctaria*
      - *glacialis* Rosenvinge

**Table 2.5 (cont'd)**

*plantaginea* (Roth) Greville
*Petalonia*
*fascia* (O. F. Müller) Kuntze
*Scytosiphon*
*lomentaria* (Lyngbye) C. Agardh
*Asperococcus*
*echinatus* (Mertens) Greville
*Omphalophyllum*
*ulvaceum* Rosenvinge
Dictyosiphonaceae
*Coilodesme*
*bulligera* Strömfelt
*Dictyosiphon*
*foeniculaceus* (Hudson) Greville

Laminariales
Chordaceae
*Chorda*
*filum* (Linnaeus) Lamouroux
*tomentosa* Lyngbye
Laminariaceae
*Saccorhiza*
*dermatodea* (De la Pylaie) J. Agardh
*Laminaria*
*agardhii* Kjellman
*digitata* (Hudson) Lamouroux
*groenlandica* Rosenvinge
*longicruris* De la Pylaie
*nigripes* J. Agardh
*saccharina* (Linnaeus) Lamouroux
*solidungula* J. Agardh
*Agarum*
*cribrosum* Bory
Alariaceae
*Alaria*
*esculenta* (Linnaeus) Greville
*grandifolia* J. Agardh
*pylaii* (Bory) Greville

Fucales
Fucaceae
*Fucus*
*distichus* Linnaeus
subsp. *distichus*
subsp. *anceps* (Harvey and Ward) Powell
subsp. *edentatus* (De la Pylaie) Powell
subsp. *evanescens* (C. Agardh) Powell
*vesiculosus* Linnaeus
*Ascophyllum*
*nodosum* (Linnaeus) Le Jolis

RHODOPHYCEAE
Bangiales
Bangiaceae
*Erythrotrichia*
*carnea* (Dillwyn) J. Agardh
*Erythrocladia*
*irregularis* Rosenvinge
*polystromatica* P. Dangeard
*Erythropeltis*
*discigera* (Berthold) Schmitz
var. *flustrae* Batters
*Porphyra*
*miniata* (C. Agardh) C. Agardh
*purpurea* (Roth) C. Agardh

Nemaliales
Acrochaetiaceae
*Acrochaetium*
*parvulum* (Kylin) Hoyt
*Audouinella*
*efflorescens* (J. Agardh) Papenfuss
*hallandicum* (Kylin) Woelkerling
*purpurea* (Lightfoot) Woelkerling
*spetsbergense* (Kjellman) Woelkerling
*Colaconema*
*membranacea* (Magnus) Woelkerling

Cryptonemiales
Dumontiaceae
*Dumontia*
*incrassata* (O. F. Müller) Lamouroux
*Neodilsea*
*integra* (Kjellman) Zinova
Squamariaceae
*Peyssonelia*
*johanseni* Howe
*rosenvingii* Schmitz
*Rhodophysema*
*elegans* (Crouan and Crouan) Dixon
*Halosacciocolax*
*kjellmanii* S. Lund
*lundii* Edelstein
Hildenbrandiaceae
*Hildenbrandia*
*prototypus* Nardo
Corallinaceae
*Clathromorphum*
*compactum* (Kjellman) Foslie
*Lithothamnium*
*foecundum* Kjellman
*glaciale* Kjellman
*laeve* (Strömfelt) Foslie
*Phymatolithon*
*laevigatum* (Foslie) Foslie
*polymorphum* (Linnaeus) Foslie
Kallymeniaceae
*Callophyllis*
*cristata* (C. Agardh) Kützing
*Kallymenia*

**Table 2.5** (cont'd)

- *schmitzii* De Toni
- Choreocolaceae
  - *Choreocolax*
    - *odonthaliae* Levring
  - *Harveyella*
    - *mirabilis* (Reinsch) Schmitz and Reinke

- Gigartinales
  - Cruoriaceae
    - *Cruoria*
      - *arctica* Schmitz
    - *Cruoriopsis*
      - *hyperborea* Rosenvinge
    - *Petrocelis*
      - *polygyna* (Kjellman) Schmitz
      - *sp.*
  - Solieriaceae
    - *Turnerella*
      - *pennyi* (Harvey) Schmitz
  - Rhodophyllidaceae
    - *Rhodophyllis*
      - *dichotoma* (Lepeschkin) Gobi
  - Phyllophoraceae
    - *Ahnfeltia*
      - *plicata* (Hudson) Fries
    - *Phyllophora*
      - *truncata* (Pallas) Newroth and Taylor
    - *Ceratocolax*
      - *hartzii* Rosenvinge

- Rhodymeniales
  - Rhodymeniaceae
    - *Halosaccion*
      - *ramentaceum* (Linnaeus) J. Agardh
    - *Rhodymenia*
      - *palmata* (Linnaeus) Greville

- Ceramiales
  - Ceramiaceae
    - *Antithamnion*
      - *americanum* (Harvey) Farlow
      - *boreale* (Gobi) Kjellman
      - *pylaisaei* (Montagne) Kjellman
    - *Ceramium*
      - *rubrum* (Hudson) C. Agardh
      - *tenuissimum* (Roth) J. Agardh
    - *Ptilota*
      - *pectinata* (Gunnerus) Kjellman
      - *plumosa* (Hudson) C. Agardh
  - Delesseriaceae
    - *Membranoptera*
      - *alata* (Hudson) Stackhouse
      - *denticulata* (Montagne) Kylin
    - *Pantoneura*
      - *angustissima* (Turner) Kylin
      - *baerii* (Postels and Ruprecht) Kylin
    - *Phycodrys*
      - *rubens* (Linnaeus) Batters
  - Rhodomelaceae
    - *Polysiphonia*
      - *arctica* J. Agardh
      - *urceolata* (Lightfoot) Greville
    - *Rhodomela*
      - *confervoides* (Hudson) Silva
      - *lycopodioides* (Linnaeus) C. Agardh
    - *Odonthalia*
      - *dentata* (Linnaeus) Lyngbye

(1980) report high macroalgal counts in Lancaster Sound (South Devon Island), less in Navy Board Inlet and Eclipse Sound, and low counts on the northeast coast of Bylot Island.

A well-developed algal canopy and understory provides a diversifed habitat for marine animals. Most plant growth occurs in the winter when nutrient levels are high under the ice. Macroalgae are very productive and most of this production goes to the detrital food chain.

*Fucus* spp. and laminarians (kelp) *Laminaria saccharina*, *L. longicruris* and *L. solidurgula* are more common in the shallow subtidal waters (0 to 5 metres), while *Agarum cribrosum*, another kelp, frequently replaces *Laminaria* at depths of 5 to 10 metres. Other common species, which inhabit the "understory" beneath the larger kelps, are *Desmarestia aculeate*, *Neodilsea integra*, *Halosaccion rumentaceum* and *Phyllophora truncata*. Below this, from 10 - 50 m is a zone dominated by *Agarum cribrosum* and a wide variety of understory species. From 50 m and lower, vegetation is mostly encrusting.

The biomass of marine plants, based on very few samples, ranged between 1.7 and 12.7 kg/m$^2$ (Table 2.6; Thomson and Cross, 1980). These values are somewhat lower than those reported from the east coast of Canada (LGL, 1983). Areas sampled by Thomson and Cross (1980) within the study region are shown in Figure 2.54.

## 2.10 PRODUCTIVITY

### 2.10.1 Primary Productivity: Phytoplankton

Information on phytoplankton populations in the Arctic is sparse and only a few studies have been carried out in the Lancaster Sound region. Sekerak et al (1976, 1979) reported on data from samples collected in the upper 50 metres of water, while chlorophyll distributions, estimated from continuous shipboard (fluorometry) analysis and from airborne surveys, were examined

Table 2.6 Biomass (g/m$^2$) of canopy and understory macrophytic algae in quantitative collections from Lancaster Sound and NW Baffin Bay during August-September 1978 and August 1979. Data in each column based on one sample located in a macrophyte bed (0.25 to 2.5 m$^2$) except for Cape Fanshawe where n = 5 (5 m) or 6 (10 m) (from Thomson and Cross, 1980).

| Depth (m) | Taxon | Philpots Island | Phoenix Head Glacier | | Navy Board Inlet | | Eclipse Sound | | Cape Fanshawe |
|---|---|---|---|---|---|---|---|---|---|
| | | 31,32[1] | 31 | 34 | 31 | 42 | 31,32[2] | 33 | 31 |
| 5 | *Laminaria* spp. | 3520; 5200 | | | | | 332 | 3464 | 541 ± 278 |
| | *Alaria grandifolia* | 240; 4 | | | | | 0 | 0 | 53 ± 16 |
| | *Agarum cribrosum* | 0 | | | | | 0 | 0 | 2 ± 4 |
| | Total Laminariales | 3760; 5204 | - | - | - | - | 332 | 3464 | 596 ± 283 |
| | *Desmarestia aculeata* | 30; 40 | | | | | 1144 | 20 | 0 |
| | *Halosaccion ramentaceum* | 0 | | | | | 0 | 0 | 70 ± 49 |
| | *Neodilsea integra* | 0 | | | | | 0 | 100 | 35 ± 23 |
| | *Phyllophora truncata* | 0 | | | | | 0 | 36 | 0 |
| | Other | 27; 11 | | | | | 48 | 0 | 18 ± 12 |
| | Total understory | 57; 51 | - | - | - | - | 1192 | 156 | 122 ± 67 |
| | Total macrophytes | 3817; 5255 | - | - | - | - | 1524 | 3620 | 718 ± 238 |
| 10 | *Laminaria* spp. | 1700 | 1706 | 2830; 4400 | 4372 | 12652 | 0 | 0 | 0 |
| | *Alaria grandifolia* | 0 | 20 | 0; 28 | 658 | 104 | 0 | 0 | <1 |
| | *Agarum cribrosum* | 0 | 0 | 2; 0 | 0 | 0 | 1033 | 0 | 416 ± 187 |
| | Total Laminariales | 1700 | 1726 | 2832; 4428 | 5030 | 12828[3] | 1033 | 0 | 416 ± 187 |
| | *Desmarestia aculeata* | 545 | 4 | 0 | 0 | 0 | 0 | 420 | 0 |
| | *Halosaccion ramentaceum* | 0 | 0 | 0 | 64 | 348 | 0 | 0 | 0 |
| | *Neodilsea integra* | 0 | 0 | 0 | 0 | 0 | 0 | 1080 | 0 |
| | *Phyllophora truncata* | 0 | 0 | 0 | 0 | 0 | 0 | 208 | 0 |
| | Other | 0 | 0 | 0 | 20 | 24 | 0 | 0 | 0 |
| | Total understory | 545 | 4 | 0 | 84 | 372 | 0 | 1708 | <1 |
| | Total macrophytes | 2245 | 1730 | 2832; 4428 | 5114 | 13200 | 1033 | 1708 | 417 ± 187 |

- Not sampled.

[1] Station 31 = 10 m; 32 = 5 m.

[2] Station 31 = 5 m; 32 = 10 m.

[3] This total also includes *Saccorhiza dermatodea*.

by Borstad and Gower (1984). Other reviewed reports include those prepared for the EAMES project, and other environmental impact statements (LGL, 1982, 1983; Norlands Petroleum Limited, 1978; Lancaster Sound Regional Study, 1980a, 1980b). Station locations are shown in Figures 2.75 and 2.76.

Phytoplankton production and abundance shows considerable variability with both time and space. Changing light intensity, temperature, mixing and upwelling of nutrients all are factors which influence production. As a consequence the data that do exist must be considered as rough estimates at best.

In general, phytoplankton biomass in Lancaster Sound appears to be about twice that in other parts of the Arctic such as the Beaufort Sea, Bridport Inlet (South coast of Melville Island) or Davis Strait (70-80 $mg/m^2$ compared to 7-60 $mg/m^2$ - depth integrated values over 0-50 metres) (LGL, 1980). Within Lancaster Sound, there were no differences between three sub-areas (north and east coast Bylot Island; central Lancaster Sound and south coast Devon Island; mouth Lancaster Sound and adjacent waters of Baffin Bay) as shown in Figure 2.75 (LGL, 1983). Data do suggest, however, that the inlets and fjords (Navy Board Inlet, Eclipse Sound, Pond Inlet) have lower phytoplankton levels compared to Lancaster Sound (Sekerak et al, 1976, 1979).

Borstad and Gower (1984) provide a much better synoptic view of plankton distribution although their data are restricted to the top 2 or 3 metres. Records of higher chlorophyll concentrations (5-10 $mg/m^3$) were recorded at the mouth of Jones Sound, off Philpots Island (E. Devon Island), and in the offshore areas of eastern Lancaster Sound, compared to 1-2 $mg/m^3$ in central or western Lancaster Sound (Figure 2.77; Table 2.7).

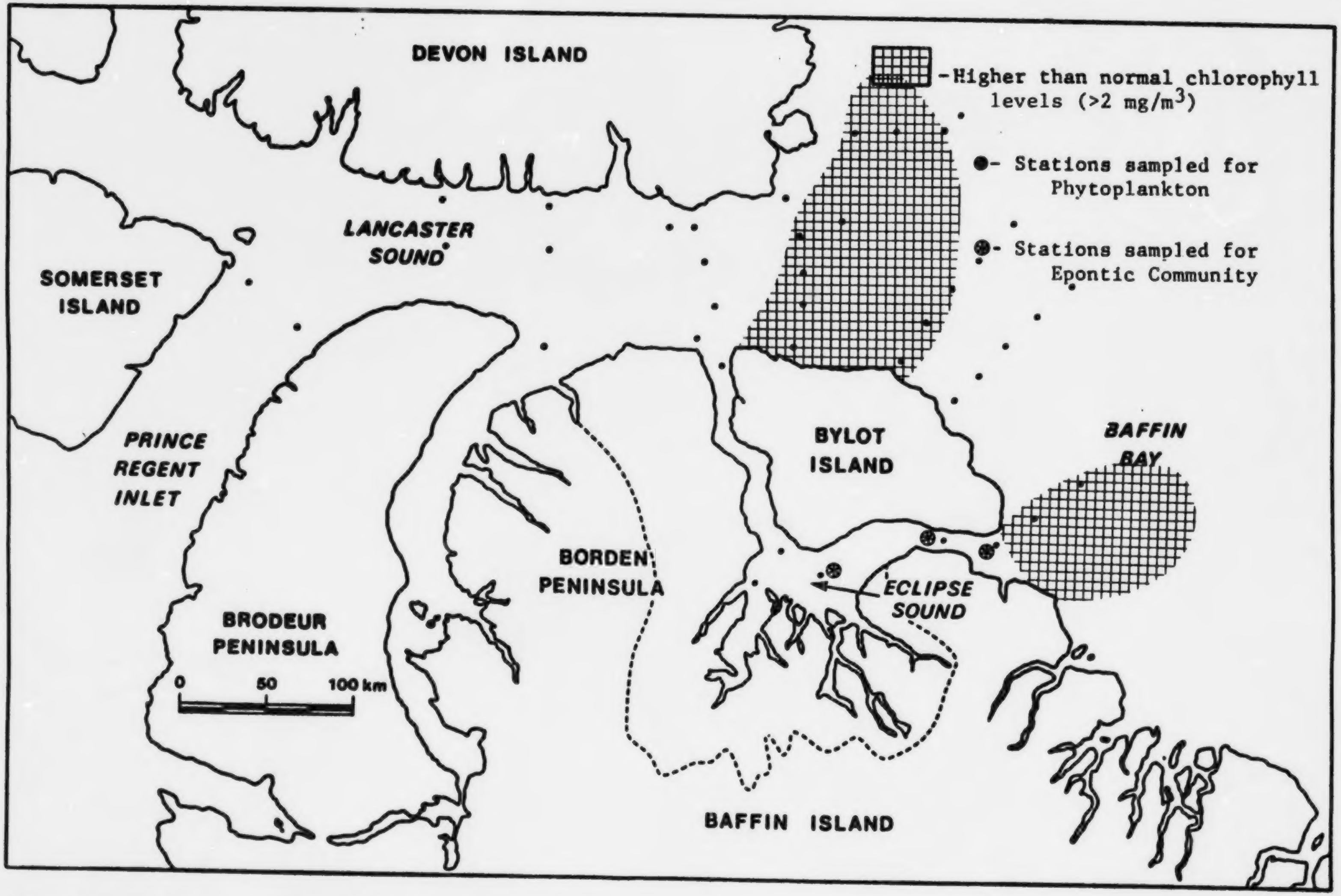

DEVON ISLAND
▦ -Higher than normal chlorophyll levels (>2 mg/m$^3$)
● - Stations sampled for Phytoplankton
⊛ - Stations sampled for Epontic Community
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.75** Primary production (from LGL, 1983).

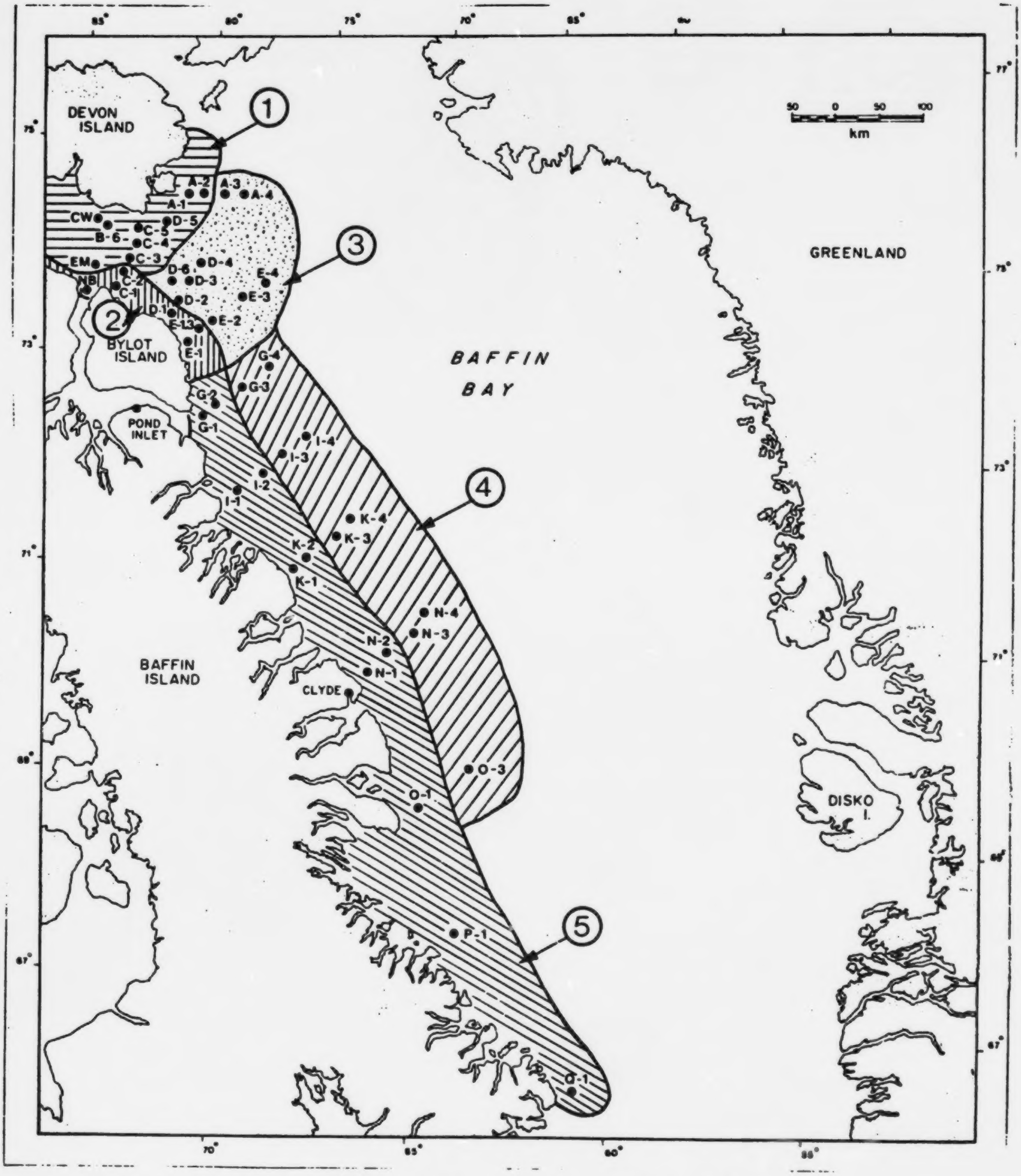

DEVON ISLAND
BYLOT ISLAND
POND INLET
BAFFIN ISLAND
CLYDE
BAFFIN BAY
GREENLAND
DISKO I.
km
50 0 50 100
①
②
③
④
⑤
A-1
A-2
A-3
A-4
CW
B-6
C-1
C-2
C-3
C-4
C-5
D-1
D-2
D-3
D-4
D-5
D-6
E-1
E-2
E-3
E-4
EM
NB
G-1
G-2
G-3
G-4
I-1
I-2
I-3
I-4
K-1
K-2
K-3
K-4
N-1
N-2
N-3
N-4
O-1
O-3
P-1
Q-1

**Figure 2.76** Locations of the five subareas where chlorophyll concentrations and total cell counts were examined for differences. Subareas were defined on the basis of currents and distance from shore (LGL, 1983).

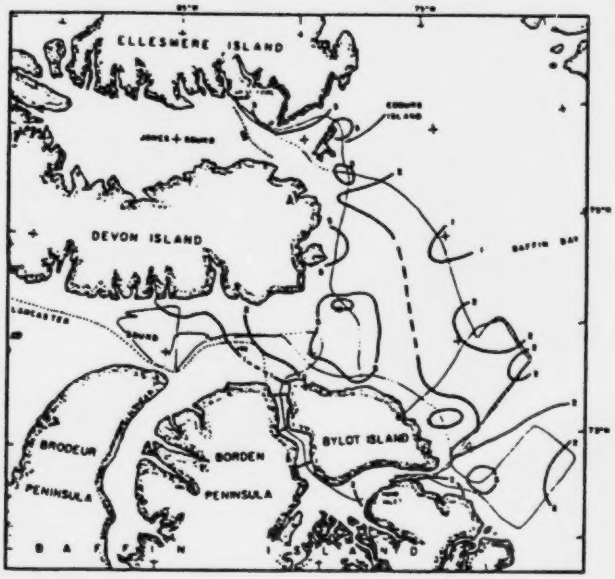

ELLESMERE ISLAND
COBURG ISLAND
JONES SOUND
DEVON ISLAND
BAFFIN BAY
LANCASTER
SOUND
BYLOT ISLAND
BRODEUR
PENINSULA
BORDEN
PENINSULA
B A F F I N I S L A N D

**Figure 2.77** Surface chlorophyll concentration (mg/m$^3$) inferred from airborne measurements of fluorescence line height (FLH) during the period 24-27 August, 1979. (From Borstad and Gower, 1984).

**Table 2.7 Chlorophyll Concentrations (from Borstad and Gower, 1984).**

| Area | Chlorophyll Concentration: from ships samples (mg/m$^3$) | Chlorophyll Concentration (mg/m$^3$): estimate from air (mg/m$^3$) |
|---|---|---|
| Central Lancaster Sound | 0.1-1.7 | 0.1-1.8 |
| E. of Bylot Island | 0.7-2.2 | 0.8-4.1 |
| S.E. of Bylot Island | 1.3-1.9 | 3.5-7.5 |
| N. of Bylot Island | 0.6-2.0 | 2.3-3.7 |

Diatoms represent 75% of the larger plankton species identified from Lancaster Sound with centric diatoms about twice as numerous as the pennates (Sekerak et al., 1976). However, Borstad and Gower (1984) found that 30-90% of the total number of cells present consisted of small unidentified microflagelates.

The most abundant diatom species was Chaetoceros socialis followed by the pennate Nitzochia grunowii. Other dominant species include Chaetoceros compressus, C. wighamii, and Dinobryon balticum (a chrysophyte). Other major taxa identified from the study area are shown in Table 2.8.

The Arctic Ocean is one of the least productive in the world due to the short growing season and strong vertical stratification which limits nutrient replenishment. Annual productivity is about 1-20 gC/m$^2$/yr, compared to 121 gC/m$^2$/yr in Atlantic shelf waters. While data from Lancaster Sound are not available, annual productivity estimates for Jones Sound, N.W.T. and Frobisher Bay, N.W.T. are 20-35 mgC/m$^2$/yr and 40-70 mgC/m$^2$/yr, respectively (LGL, 1982). There is some indication that primary productivity in Lancaster Sound may be relatively high compared to other areas in the Arctic (Davis Strait, Baffin Bay; LGL, 1982).

**Table 2.8 Major Phytoplankton Species Recorded or Expected in Lancaster Sound and Adjacent Waters**

- Bacillariophyceae
  - Centrales
    - *Chaetoceros compressus*
    - *C. debilis*
    - *C. furcellatus*
    - *C. laciniosus*
    - *C. septentrionalis*
    - *C. socialis*
    - *C. wighamii*
    - *Eucampia zodiacus*
    - *Porosira glacialis*
    - *Thalassiosira condensata*
    - *T. fluviatilis*
    - *T. frigida*
    - *T. gravida*
    - *T. nordenskioeldii*
    - *T. polychorda*
  - Pennales
    - *Achnanthes taeniata*
    - *Nitzschia cylindrus*
    - *N. grunowii*
    - *N. seriata*
    - *N. delicatissima*

- Chrysophyceae
  - *Dinobryon balticum*

- Dinophyceae
  - *Peridinium breve*
  - *P. minusculum*
  - *P. pellucidum*

### 2.10.2 Epontic (Under-ice) Community

The epontic or under-ice community is made up primarily of unicellular algae and smaller invertebrates, the latter dominated by amphipods but also including nematodes, harpacticoid and cyclopoid copepods and polychaetes. Most of the data available are from studies reported by Cross (1980, 1982); Cross et al (1984), and in review articles including the EAMES project (LGL, 1983) and the Lancaster Sound environmental impact statement (LGL, 1982).

Pennate diatoms, especially Nitzsihia grunowii and N. frigida, are the dominant algae (70-99%); other species recorded are given in Table 2.9. They occur as colonies within brine cells in the interstices of the ice crystals. The species which is dominant can vary widely with time and/or location.

Algal biomass also varies considerably, with chlorophyll values ranging between 10 and 913 mg/m$^3$ reported for Pond Inlet/Eclipse Sound (Cross, 1980) and cell numbers between <1 x 10$^6$ to 160 x 10$^6$ cells per litre (Hsiao, 1979; Cross, 1982). These values are similar to data reported from other parts of the Arctic (LGL, 1982).

Epontic primary production has not been measured in the Lancaster Sound region - values from other areas range between 0.1 and 133 mgC/m$^3$/hr (LGL, 1982). Factors affecting primary production include snow cover and available light; however, it has been estimated that up to 25% of the annual productivity in Eclipse Sound is contributed by the ice flora (LGL, 1983).

Gammarid amphipods are the principal invertebrates in the epontic community. Major species reported from Pond Inlet include Apherusa glacialis, Ischyrocerus anquipes and Onisimus spp. (Cross, 1982). Other invertebrate species recorded, including mysids, are presented in Table 2.9. Arctic cod are also commonly found in the epontic community.

**Table 2.9 Species Present in Epontic Communities, (LGL, 1982), Cross and Martin, 1983.**

FLORA

Pennate Diatoms

*Nitzschia frigida*
*Nitzschia cylindrus*
*Nitzschia grunowii*
*Navicula pelagica*
*Navicula marina*
*Navicula quadripedis*
*Navicula transitans*
*Schnanthes taeniata*

Centric Diatoms

*Chaetoceros* spp.
*Thalassiosira* spp.
*Melosira* spp.

Small numbers of clinoflagelates, microflagellates and cryptomonads.

FAUNA

Amphipods

*Onisimus* (= *Pseudalibrotus*) *titoralis*
*Gammarus wilkitzkii*
*Gammarus setasus* ( *O. litoralis*
*Gaminaracanthus loricatus* ( *O. glacialis*
*Apherusa glacialies* ( *O. nanseni*
*Anonyx mugax*
*A. laticoxae*
*Atylus carinatus*
*Boeclcosimus edwardsi*
*Parapleustes* sp.
*Eusirus holmi*
*Ischyrocerus anquipes*
*Weyprechtia Pinguis*
*Orchomene minutis*
*Guernea* sp.

MYSIDS

*Mysis litoralis*
*M. oculata*
*M. polaris*

Considerable variability in epontic biomass has been reported, between 1 and 600 mg/m$^3$ from Pond Inlet (Cross, 1982; Cross and Martin, 1983). These values are low compared to those from the benthic community (e.g., 3-9 g/m$^2$) (LGL, 1982), but the large areal extent of the ice cover suggests that the contribution of the epontic community is not insignificant. Total abundance of meiofauna (nematodes, harpacticoid and cyclopoid copepods and polychaetes) ranged between 300 and 53,000 individuals/m$^2$ with higher densities associated with high microalgal populations. Cross and Martin (1983) found that Ischyrocerus sp. and Weyprechtia pinguis were dominant by numbers and W. pinguis and Gammarus setosus were the most abundant with respect to biomass, during the two years of the BIOS study. Most of the species were of benthic origin.

### 2.10.3 Secondary Productivity: Zooplankton and Ichthyoplankton

Zooplankton are a very important component of the Arctic food web, forming a fundamental trophic link between phytoplankton and vertebrates. Arctic cod, many of the seabirds, and several species of marine mammals feed extensively on this group.

Copepods are the major component of the zooplankton community and in Lancaster Sound they constitute 79% of the total biomass in the upper 150 metres (Sekerak et al, 1976). Other groups include ostracods, mysids, amphipods, decapods, crustaceans, euphausiids, coelenterates, chaetognaths and pteropods. Larval fish (ichthyoplankton) and invertebrates (e.g., barnacles, echinoderms, molluscs) also will contribute to the plankton population for a portion of the year.

The zooplankton species recorded from Lancaster Sound are primarily those common to most Arctic waters. Generally a few species dominate and at Lancaster Sound the six most abundant contribute over 85% of total numbers (LGL, 1983). Fifty-seven species were reported from Lancaster Sound, with the copepod Pseudocalanus minutus the most common. Next in abundance were the copepods Oithona similis, Metridia longa and Microcalanus spp. (LGL, 1983). While a substantial number of "rare and unusual" species were collected in Lancaster Sound, this is more likely due to the intensive sampling carried out as part of the EAMES program. Major zooplankton species are listed in Table 2.10.

There are data only for Lancaster Sound and Western Baffin Bay; no zooplankton samples have been collected from Pond Inlet or Eclipse Sound. Offshore stations in Lancaster Sound appeared to be lower in total biomass than stations along Bylot Island. In general, biomass values were higher in Lancaster Sound (ca 150-400 mg/m$^3$) compared to other areas such as Foxe Basin, Ellesmere Island, Somerset Island or Bridport Inlet (ca 30-190 mg/m$^3$; LGL, 1982). Depth was the most important factor affecting zooplankton distribution with maximum biomass in the upper 50 metres (546 individuals/m$^3$ versus 10-85/m$^3$ between 50 and 1,200 m). Details on the abundance and biomass of various zooplankton groups over a series of depth intervals are given in Table 2.11.

Within Lancaster Sound/northwestern Baffin Bay three subareas were identified which appeared to show unique zooplankton assemblages (areas I, II, III - Figure 2.78). Subarea II (offshore) generally had a lower biomass than the two inshore/coastal areas.

Ichthyoplankton consisted of six species. Planktonic arctic cod concentrations in Lancaster Sound appear to be about twice those from other arctic regions (5.2/100m$^3$ versus 2.8/100m$^3$) (Norlands Petroleum Limited, 1978). Arctic cod (87%) and the gelatinous seasnail (11%) made up most of the population (by numbers); the dusky snailfish, Greenland seasnail, Atlantic sea poacher and an unidentified sculpin each contributed less than 1%. (See Section 2.4 for scientific names).

**Table 2.10 Common Zooplankton Species in Lancaster Sound**

COPEPODA

*Calanus hyperboreus*
*C. glacialis*
*Pseudocalanus minutus*
*Microcalanus pygmaeus*
*Pareuchaeta glacialis*
*Metridia longa*
*Oithona similis*
*Oncaea borealis*
*Spinocalanus magnus*
*S. longicornis*
*Gadius brevispinus*
*Gadius tenuispinus*
*Heterorhabdus norvegicus*
*Heterostylites major*

OSTRACODA

*Conchoecia maxima*

AMPHIPODA

*Parathemisto libellula*
*P. abyssorum*

MYSIDS

*Boreomyis arctica*
*B. nobilis*

DECAPODA

*Hymenodora glacialis*

CHAETOGNATA

*Sagitta elegans*
*Eukrohnia hamata*

LARVACEA

*Oikopleura vanhoeffeni*
*Fritillaria borealis*

PTEROPODA

*Limacina helicina*
*Clione limacina*

COELENTERATA

*Aglantha digitale*
*Aeginopsis laurenti*

Data compiled from Graingar, 1965; Tidmarsh, 1973; Sekerak, et al, 1976.

**Table 2.11 Mean Abundance of Major Groups of Zooplankton in Eastern Lancaster Sound and Western Baffin Bay, 23 July to 10 October, 1978.**

| Depth (m) | 50-0 (n=39) | | | | 150-50 (n=38) | | | | 250-150 (n=38) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Abundance | | Biomass | | Abundance | | Biomass | | Abundance | | Biomass | |
| Group | mean no./m³ | % of total | mean mg/m³ | % of total | mean no./m³ | % of total | mean mg/m³ | % of total | mean no./m³ | % of total | mean mg/m³ | % of total |
| Hydrozoa | 6.05* | 1.11 | 7.53 | 1.88 | 0.72* | 0.85 | 1.77 | 2.09 | 0.53* | 0.87 | 5.06 | 4.75 |
| Ctenophora | 0.04 | 0.01 | 1.80 | 0.45 | D | D | 2.87 | 3.38 | <0.01* | 0.01 | 28.99 | 27.21 |
| Polychaeta (mostly larvae) | 5.14 | 0.94 | 0.03 | 0.01 | 0.24 | 0.28 | <0.01 | <0.01 | 0.15 | 0.25 | 0.01 | 0.01 |
| Gastropoda | 24.90 | 4.56 | 18.46 | 4.62 | 1.51 | 1.79 | 0.06 | 0.07 | 1.08 | 1.77 | 1.12 | 1.05 |
| Bivalvia (young) | 1.94 | 0.36 | P | P | 0.23 | 0.27 | P | P | 0.05 | 0.08 | P | P |
| Myodocopa | 0.13 | 0.02 | 0.07 | 0.02 | 0.31 | 0.37 | 0.19 | 0.22 | 0.85 | 1.39 | 0.55 | 0.52 |
| Cirripedia (larvae) | 1.88 | 0.34 | 0.01 | <0.01 | 0.13 | 0.15 | P | P | 0.05 | 0.69 | P | P |
| Copepoda | 481.53 | 88.23 | 334.29 | 83.59 | 78.66 | 93.07 | 71.73 | 84.60 | 55.78 | 91.46 | 61.88 | 58.09 |
| Calanoida | 346.17 | 63.42 | 332.67 | 83.24 | 63.42 | 75.04 | 71.61 | 84.46 | 45.76 | 75.03 | 61.80 | 58.01 |
| Harpacticoida | 0.50 | 0.09 | P | P | 0.04 | 0.05 | P | P | 0.05 | 0.08 | <0.01 | <0.01 |
| Cyclopoida | 134.86 | 24.71 | 1.42 | 0.36 | 15.20 | 17.98 | 0.12 | 0.14 | 9.96 | 16.33 | 0.08 | 0.08 |
| Mysidae, Cumacea and Euphausiidae | 0.01 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | 0.10 | 0.12 | 0.01 | 0.02 | 0.09 | 0.08 |
| Isopoda | 0.10 | 0.02 | <0.01 | <0.01 | 0.03 | 0.04 | P | P | 0.03 | 0.05 | P | P |
| Amphipoda | 1.60 | 0.29 | 16.06 | 4.02 | 0.58 | 0.69 | 2.91 | 3.43 | 0.29 | 0.48 | 3.39 | 3.18 |
| Decapoda | <0.01 | <0.01 | 0.04 | 0.01 | <0.01 | <0.01 | <0.01 | <0.01 | - | - | - | - |
| Echinodermata (plutei) | 19.30 | 3.54 | P | P | 1.11 | 1.31 | P | P | 0.34 | 0.56 | P | P |
| Asteroidea (juveniles) | <0.01 | <0.01 | P | P | 0.03 | 0.04 | P | P | 0.01 | 0.02 | P | P |
| Chaetognatha | 3.24 | 0.59 | 19.41 | 4.85 | 0.97 | 1.15 | 5.16 | 6.09 | 1.66 | 2.72 | 5.32 | 4.99 |
| Larvacea | Uncounted, unweighed. In general terms larvaceans *Fritillaria borealis* and especially *Oikopleura vanhoeffeni* were common (about 1 to 50/m³) in the water column. Both were most abundant in the 50 to 0 m depth interval. | | | | | | | | | | | |
| Osteichthyes | 0.03 | 0.01 | 2.18 | 5.45 | - | - | - | - | <0.01 | <0.01 | 0.13 | 1.22 |
| Grand Total** | 545.75 | | 399.90 | | 84.52 | | 84.79 | | 60.99 | | 106.53 | |

D = damaged and, therefore, uncountable; P = present in samples in quantities <1.0 mg and, therefore, unweighable (from LGL, 1983).

**Table 2.11** (cont'd)

| Depth (m) | 1200 (or bottom)-250 (n=34) | | | | 1900-1200 (n=1) | | | |
|---|---|---|---|---|---|---|---|---|
| | Abundance | | Biomass | | Abundance | | Biomass | |
| Group | mean no./m³ | % of total | mean mg/m³ | % of total | mean no./m³ | % of total | mean mg/m³ | % of total |
| Hydrozoa | 0.59* | 1.58 | 5.30 | 5.10 | 0.04 | 0.41 | 31.30 | 51.09 |
| Ctenophora | 0.02* | 0.05 | 4.27 | 4.11 | - | - | - | - |
| Polychaeta (mostly larvae) | 0.18 | 0.48 | 0.29 | 0.28 | 0.01 | 0.10 | P | P |
| Gastropoda | 0.17 | 0.45 | 1.22 | 1.17 | - | - | - | - |
| Bivalvia (young) | <0.01 | <0.03 | P | P | - | - | - | - |
| Myodocopa | 2.16 | 5.78 | 1.68 | 1.62 | 0.06 | 0.62 | 0.10 | 1.63 |
| Cirripedia (larvae) | 0.01 | <0.03 | P | P | - | - | - | - |
| Copepoda | 33.28 | 88.98 | 63.95 | 61.54 | 9.46 | 97.53 | 4.35 | 7.10 |
| Calanoida | 31.64 | 84.60 | 63.95 | 61.54 | 6.13 | 63.20 | 4.35 | 7.10 |
| Harpacticoida | 0.03 | 0.08 | <0.01 | <0.01 | 0.08 | 0.82 | P | P |
| Cyclopoida | 1.61 | 4.30 | <0.01 | <0.01 | 3.25 | 33.51 | P | P |
| Mysidae, Cumacea and Euphausiidae | 0.05 | 0.13 | 3.30 | 3.18 | - | - | - | - |
| Isopoda | 0.02 | 0.05 | P | P | 0.02 | 0.21 | P | P |
| Amphipoda | 0.24 | 0.64 | 2.25 | 2.17 | 0.04 | 0.41 | 0.92 | 1.50 |
| Decapoda | 0.01 | 0.03 | 1.85 | 1.78 | 0.06 | 0.62 | 24.60 | 40.15 |
| Echinodermata (plutei) | 0.02 | 0.05 | P | P | - | - | - | - |
| Asteroidea (juveniles) | <0.01 | <0.03 | P | P | - | - | - | - |
| Chaetognatha | 0.90 | 2.41 | 19.70 | 18.76 | - | - | - | - |
| Larvacea | | | | | | | | |
| Osteichthyes | - | - | - | - | - | - | - | - |
| Grand Total** | 37.40 | | 103.92 | | 9.70 | | 61.27 | |

* Additional damaged specimens not included
** Including additional minor groups

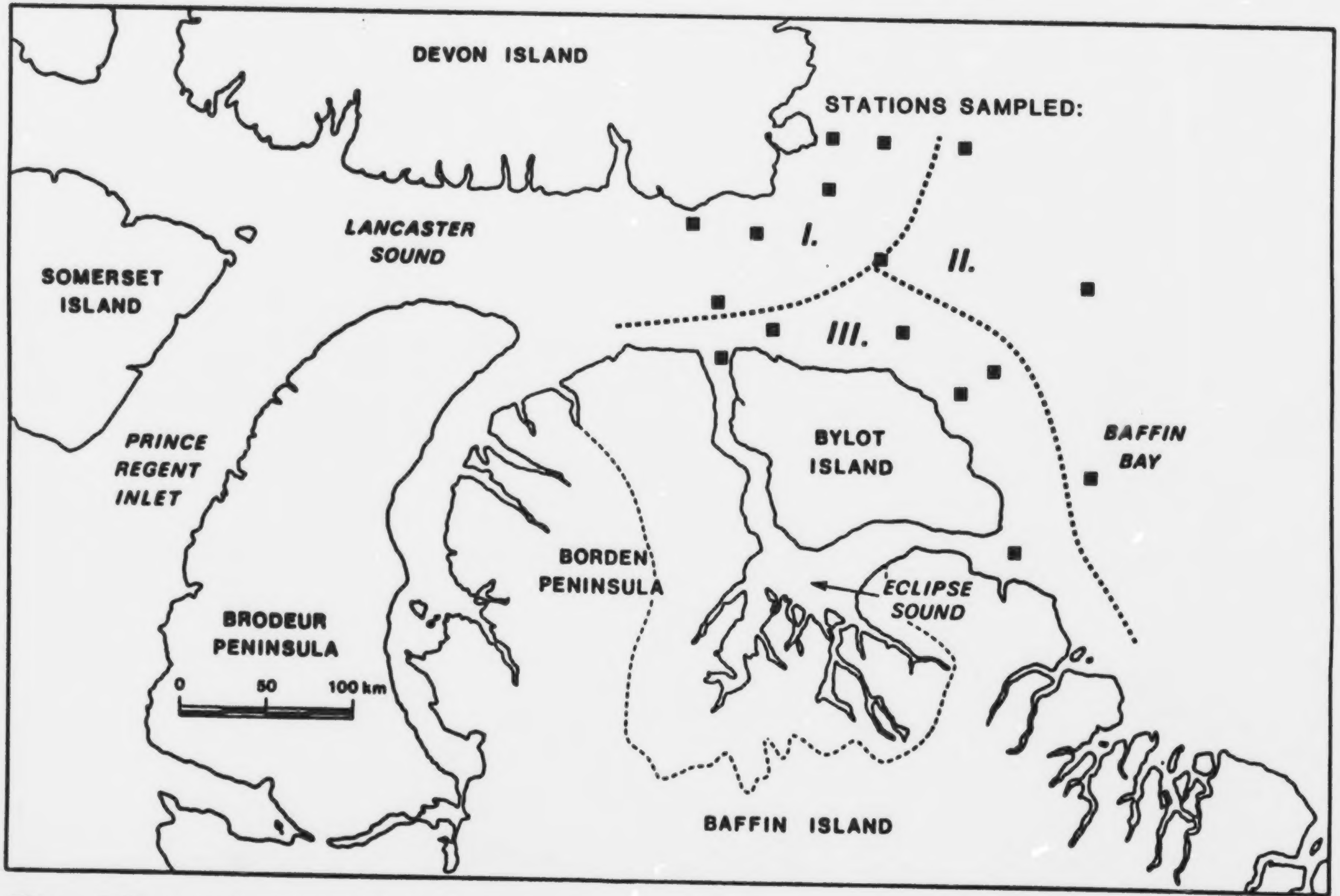

DEVON ISLAND
STATIONS SAMPLED:
LANCASTER SOUND
SOMERSET ISLAND
I.
II.
III.
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

Figure 2.78 Secondary productivity.

Very little is known about arctic cod spawning, although it is believed to take place from the end of December to March (Bering Sea data). Cod eggs are buoyant, and larvae remain planktonic (upper 50 m) for several months after hatching. Juvenile cod are benthic or associated with the undersurface of ice.

## 2.11 MARINE HISTORY

For centuries, the early inhabitants of the Arctic Small Tool tradition, Dorset, the Thule and finally the contemporary Inuit cultures have inhabited the eastern arctic region. The lifestyle of the Inuit and their ancestors was closely tied to the land and environment in which they lived, being maintained on a purely subsistence level. Early contact with European explorers and more importantly with the whaling and trading companies of Europe, changed the pattern of Inuit life by adding an economic base. Hunting and fishing was no longer just for food and clothing, but provided a means to acquire material items through trade. Today the economy of the Inuit people of the Lancaster Sound region is a combination of both subsistence and trade. In addition the development of mining and oil exploration in the arctic has recently added wage employment, as has the development of government infrastructure and tourism.

### 2.11.1 Prehistory Of The Region

About 5,000 years ago a distinctive cultural group developed on the east shore of the Bering Strait in what is now Alaska. These people used a unique form of tiny flint blades set in bone for cutting meat and skins. It is the distribution of those blades (known as the Arctic Small Tool tradition) which has allowed archeologists and anthropologists to trace the movement of this culture across the arctic (Figure 2.79). According to the dates of their many camps, they moved steadily and within a century or two occupied the Arctic coast from Alaska to Greenland.

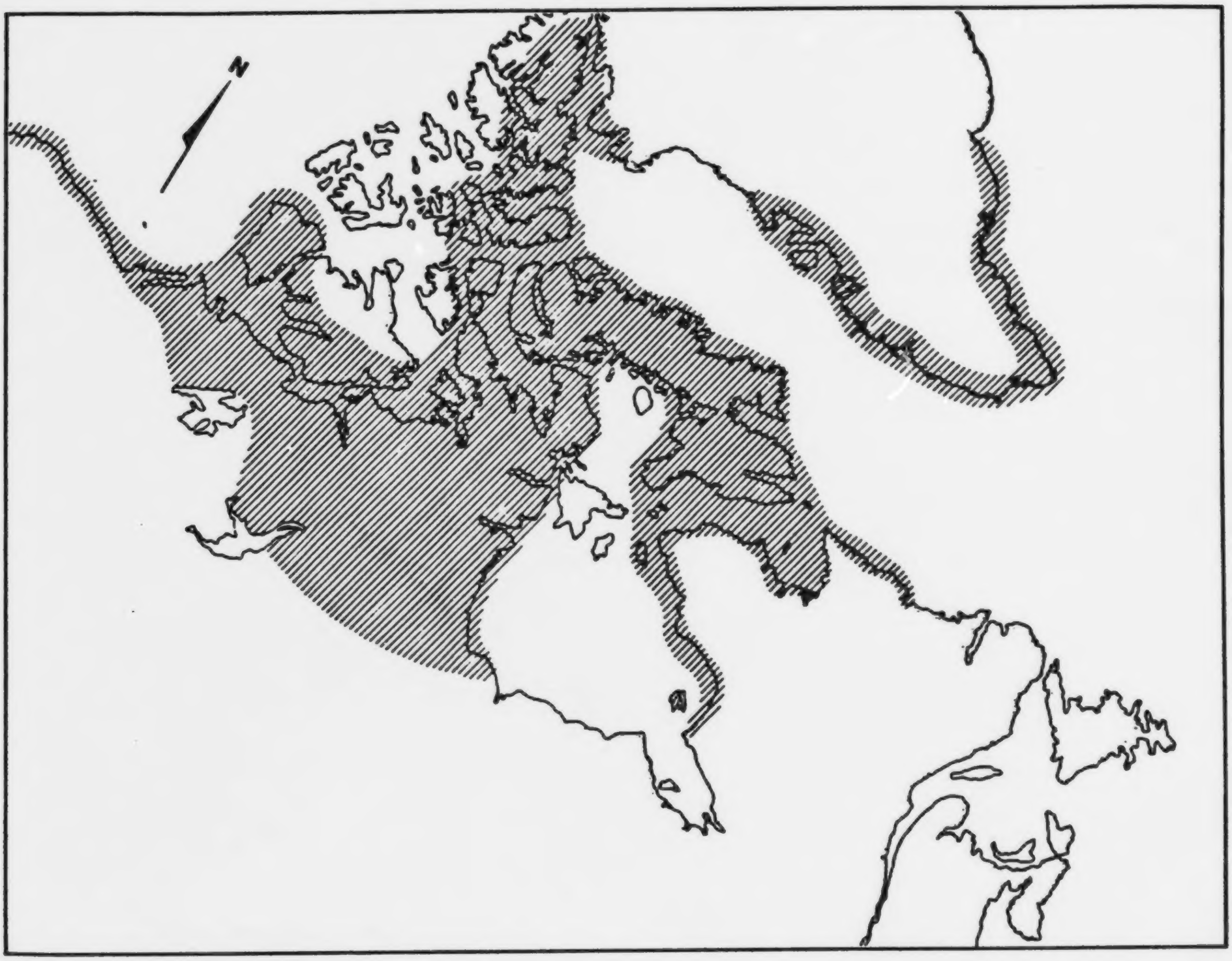


**Figure 2.79** Probable area occupied by the Arctic Small Tool tradition cultures (2000 - 800 B.C.) (from McGhee, 1978).

The origin of these people is unclear as earlier records within the Bering Sea area suggest several possible alternatives. The two more prominent theories are (a) that the Arctic Small Tool tradition culture developed from earlier cultures which crossed over from Siberia prior to the submergence of the Bering land bridge about 10,000 years ago, and (b) that the Arctic Small Tool tradition people are related to a second migration of Siberian Neolithic and related Eskaheut or Chukotan people which crossed the Bering Strait about 5,000 years ago.

The spread of the Arctic Small Tool tradition culture across the arctic appears to have been in two waves. The first, known as the Independence I culture, spread across the high arctic toward Greenland between 2000 and 1700 B.C., and a second wave known as the Pre-Dorset culture spread out toward Hudson Bay between 1700 and 800 B.C..

Independence I camps are scattered across northern Greenland and on Ellesmere, northern Devon and Cornwallis Islands. Remains in these sites suggest that the lifestyle of these people was meager and probably filled with hardships. The people were nomadic in nature and camps were small and probably occupied for only a few days or weeks and never used again. The Independence I people may have occupied the Lancaster Sound/Eclipse Sound region; however, there is no direct evidence of this.

The second migration of the Arctic Small Tool tradition people, known as the Pre-Dorset culture, spread out across the lower arctic region. It is not clear whether the Pre-Dorset people constituted a new wave of migration or simply a later phase of a continuing migration which started with the Independence I people. However, there are definite distinctions between the two cultures. Most important is the community lifestyle. Camp sites are considerably larger than those of the Independence I people. The remains of individual camps are clustered together in areas that appear to have been used seasonally over several generations. The more successful spread of the Pre-Dorset culture may have been partially because of a milder climate, due to an arctic warming trend around 1600 B.C., and also because of a more efficient adaption to the arctic environment. Large numbers of sea mammal bones (e.g. seals and polar bears) at shore camps would suggest the possible use of small boats and improved hunting techniques. The core area of the Pre-Dorset culture was centred around the Foxe Basin and northern Hudson Bay area. Hunting and family groups of up to 100 people moved into the unoccupied rich hunting regions of Eclipse Sound around 1600 B.C.. Few Pre-Dorset remains are found in the high arctic with definite occupation being established only for sites at Port Refuge on northern Devon Island (McGhee, 1978).

After 1500 B.C. the arctic climate cooled again and the Pre-Dorset people were forced south. This was probably due not only to the harsher winter conditions but to changes in the migration patterns of their food supply brought on by the environmental conditions. Remains of the Pre-Dorset culture are not found anywhere in the arctic after 800 B.C. other than the species-rich core area of northern Hudson Bay and Foxe Basin. It was here that new technological elements were combined to form the Dorset culture.

The evolution between the Pre-Dorset culture and the Dorset culture was gradual with styles of artifacts changing continuously between 1000 and 500 B.C. There was possible interaction with the Alaskan Norton culture which was wide spread in Alaska and east to the Mackenzie River and more probably with the Archaic Indian culture of northern Labrador; however, there is no conclusive evidence of this.

The adaption of the Dorset people to the colder climate of the region may be related to the development of improved equipment designed for living and hunting on sea ice (e.g., efficient harpoons and small boats). Small objects found in a Dorset campsite at Button Point on the southeast corner of Bylot Island appear to be kayak ribs (McGhee, 1978). This was important because during these colder times winter ice was more extensive and lasted a greater part of the year.

Large Dorset sites were established in northern Foxe Basin, Pond Inlet and on both sides of Hudson Bay. The peak of the Dorset culture appears to be between 500 and 1000 A.D. when it extended from Newfoundland to northwestern Greenland and as far west as Victoria and Melville Islands (McGhee, 1978); see Figure 2.80.

The Dorset culture developed a unique way of life over a period of 3000 years in the harsh environment of the Canadian arctic. However, within a relatively short period of time the Dorset people deminished and were extinct in most areas with the possible exception of the Hudson Bay area by 1000 A.D. There is no evidence of a direct cause for this extinction, however changes in the arctic climate were taking place at this time. Rapidly warming climates caused marked changes in sea-ice conditions that the Dorset hunter may not have been prepared for.

This warming trend also opened up the way for a second major migration of people from the west, the ancestors of the present day Inuit people, known as the Thule Culture, so named after Thule in northwestern Greenland where it was first identified. Records of contact with the Dorset people, called the Tunit, are found in the legends and lore of the modern Inuit. It was this warming trend between 900 and 1200 A.D. that may have also influenced the Norse expansion to Greenland and eastern Canada.

The rapid spread of the Thule Culture across the arctic (Figure 2.81) appears to have been closely related to the development of techniques for hunting large whales, which were perfected by Bering Sea hunters. Sites on Devon Island and near the community of Arctic Bay contain large piles of whale bones near Thule shore camps (McGhee, 1978).

Most early Thule villages were small, consisting of a few winter houses and probably occupied by fewer than fifty people. Camps of this size were probably the major social unit of the Thule Inuit, a loose grouping of related families who lived together in the winter and hunted together during the summer (McGhee, 1978).

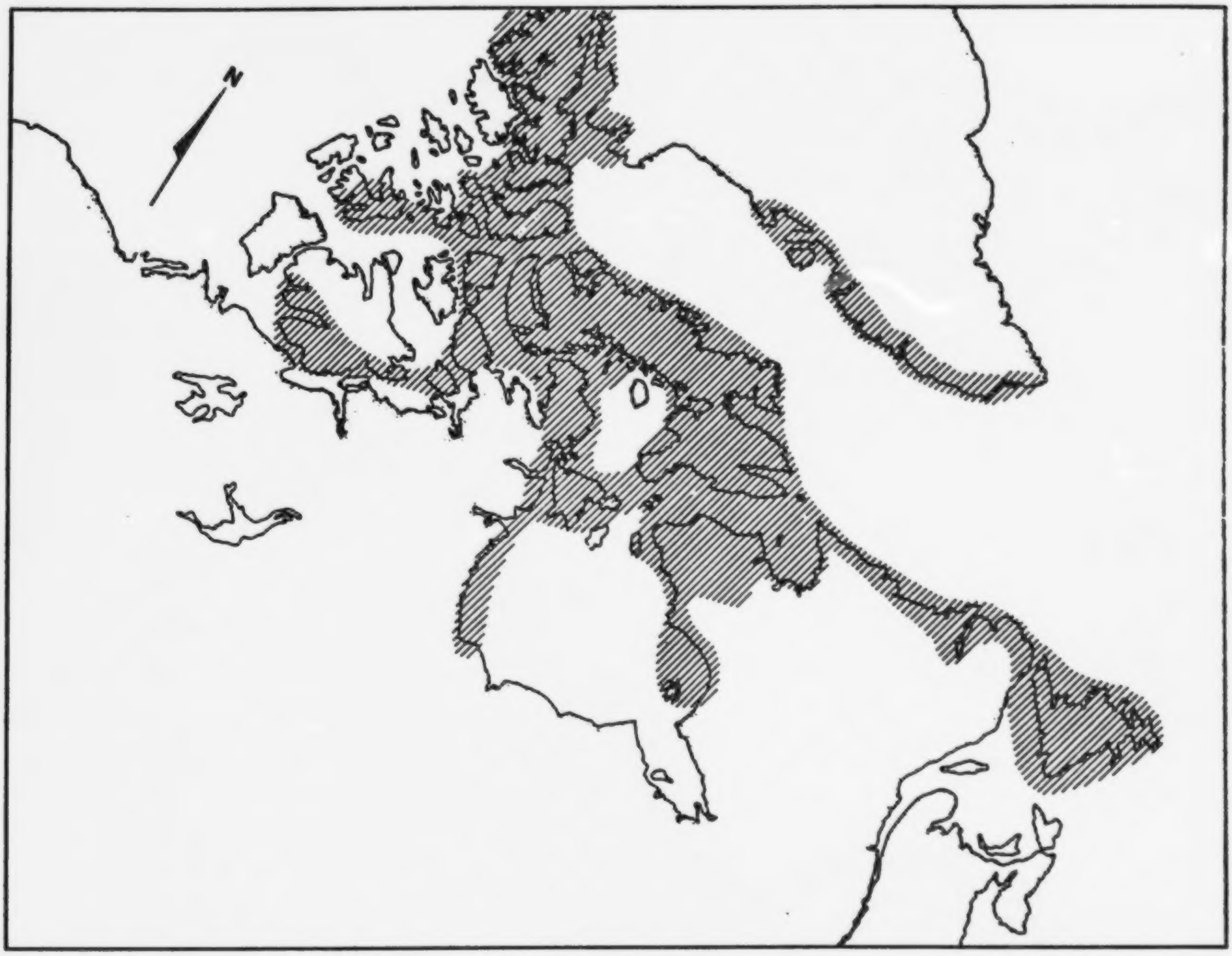


**Figure 2.80** Probable area occupied by the Dorset Culture (800 B.C. to A.D. 1000) (from McGhee, 1978).

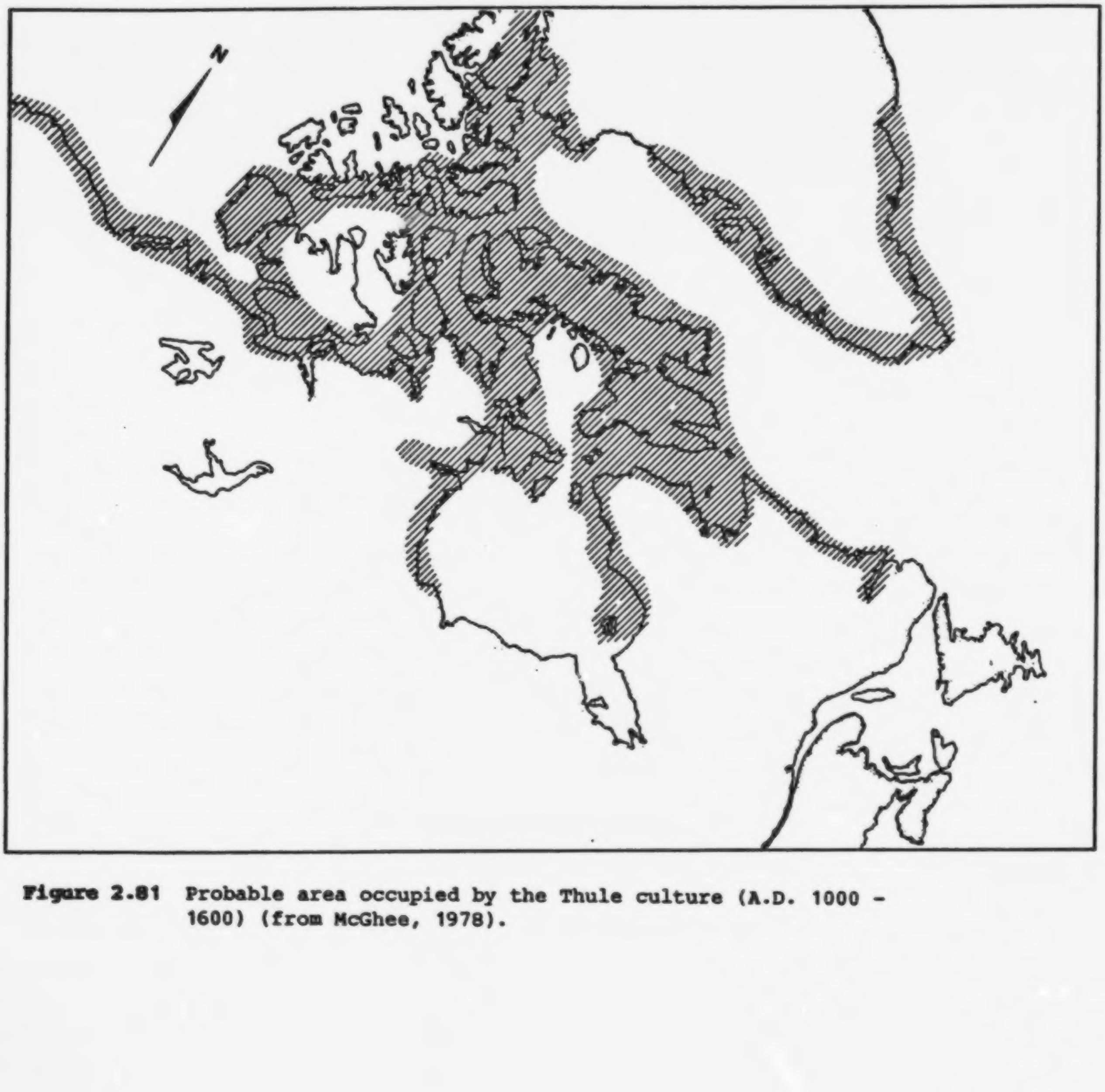


**Figure 2.81** Probable area occupied by the Thule culture (A.D. 1000 - 1600) (from McGhee, 1978).

Early contact with non-Inuit cultures is evident from Thule excavations which have produced iron tips for harpoon heads and blades for knives. Most of this iron was probably passed from village to village as trade items originating either in Siberia or in the Norse colonies in Greenland. A site at Nunguvik on the western shore of Navy Board Inlet has produced fragments of wood with nail holes dating from 1280 A.D. (Mary-Rousseliere, 1984). Early documentation of contact between the Thule people and the European nations was as early as the 16th century with the exploration of southern Baffin Island by Martin Frobisher and John Davis.

The wide distribution of the Thule culture across the arctic was again disrupted with the advance of a little ice age which began about 1200 A.D. and reached a peak between roughly 1600 and 1850. Harsher winter conditions forced the Thule people out of many geographical regions (for example the coast of Devon Island), resulting in isolated local cultures, each adapted to the resources of a specific area (Figure 2.82). The present day Inuit people within the Lancaster Sound/Eclipse Sound region are descendants of the Iglulingmiut people of the Igloolik group, which extends over Bylot Island, northern Baffin Island and Melville Peninsula. Evidence collected in Pond Inlet and Arctic Bay strongly suggests that the cultural heart of the region has always been in the Eclipse Sound area with the larger concentrations of population on the west side of Navy Board Inlet and the fjords south of Eclipse Sound (Milton Freeman Research Limited, 1976). The concentrated use of this part of the eastern arctic is clearly shown by the large number of old campsites found along these sections of coastline (Figure 2.83). Many of these camps are found in places which were also used by the earlier Dorset cultures. This is not suprising as most Inuit camps are found in areas of easy shore access or good hunting and fishing.

During the little ice age, the local people within this area appear to have abandoned their permanent winter houses, and substituting skin-covered houses for the early winter and moving onto the stable sea-ice. In the winter they lived in snowhouse villages (McGhee, 1978). Summers were spent in small shore camps, hunting along the ice edge and fishing in rivers along the coast. The Iglulingmiut were relatively isolated from the

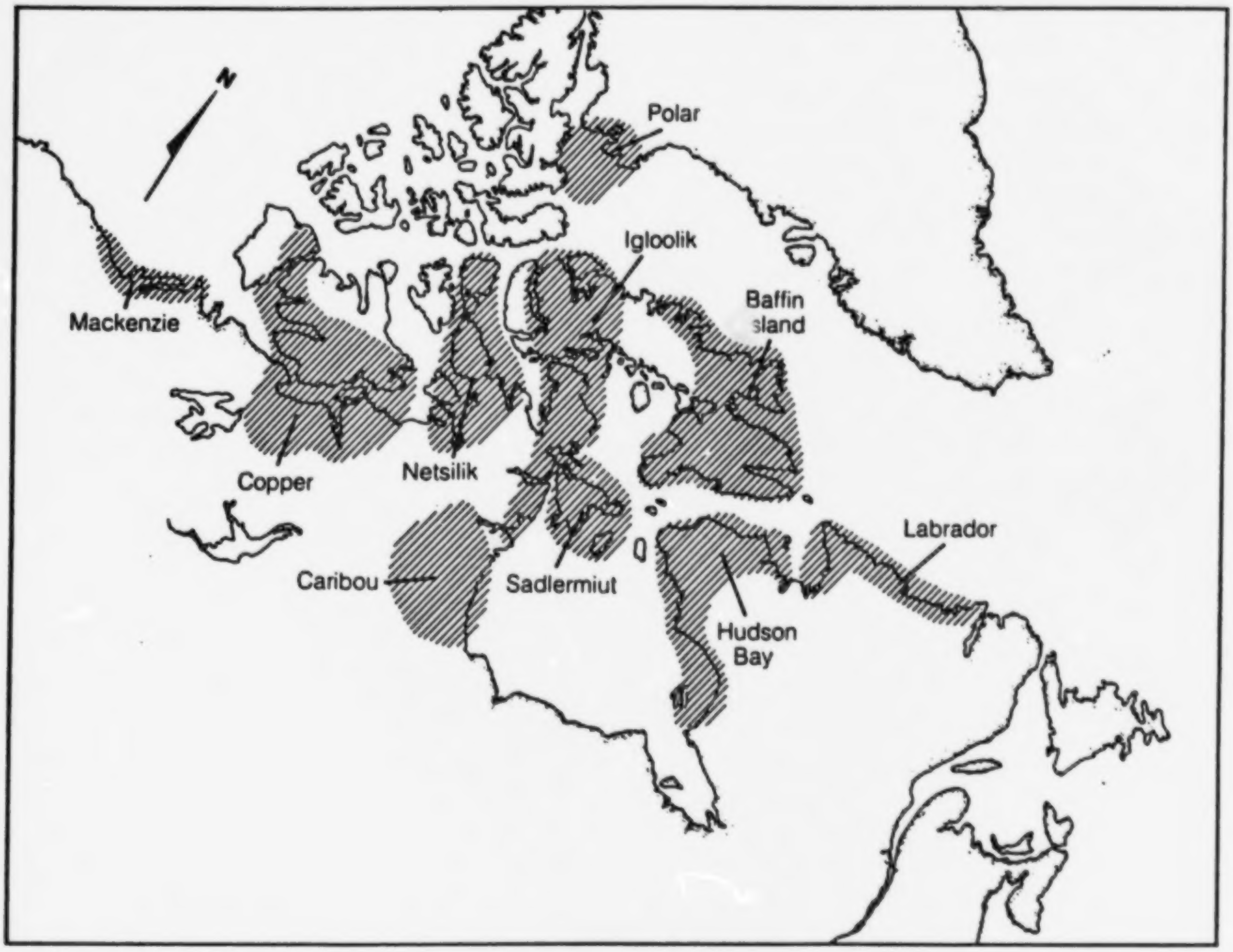

N
Polar
Igloolik
Baffin
Island
Mackenzie
Copper
Netsilik
Caribou
Sadlermiut
Hudson
Bay
Labrador

**Figure 2.82** Historic Inuit occupations of Arctic Canada (A.D. 1600 - 1850) (from McGhee, 1978).

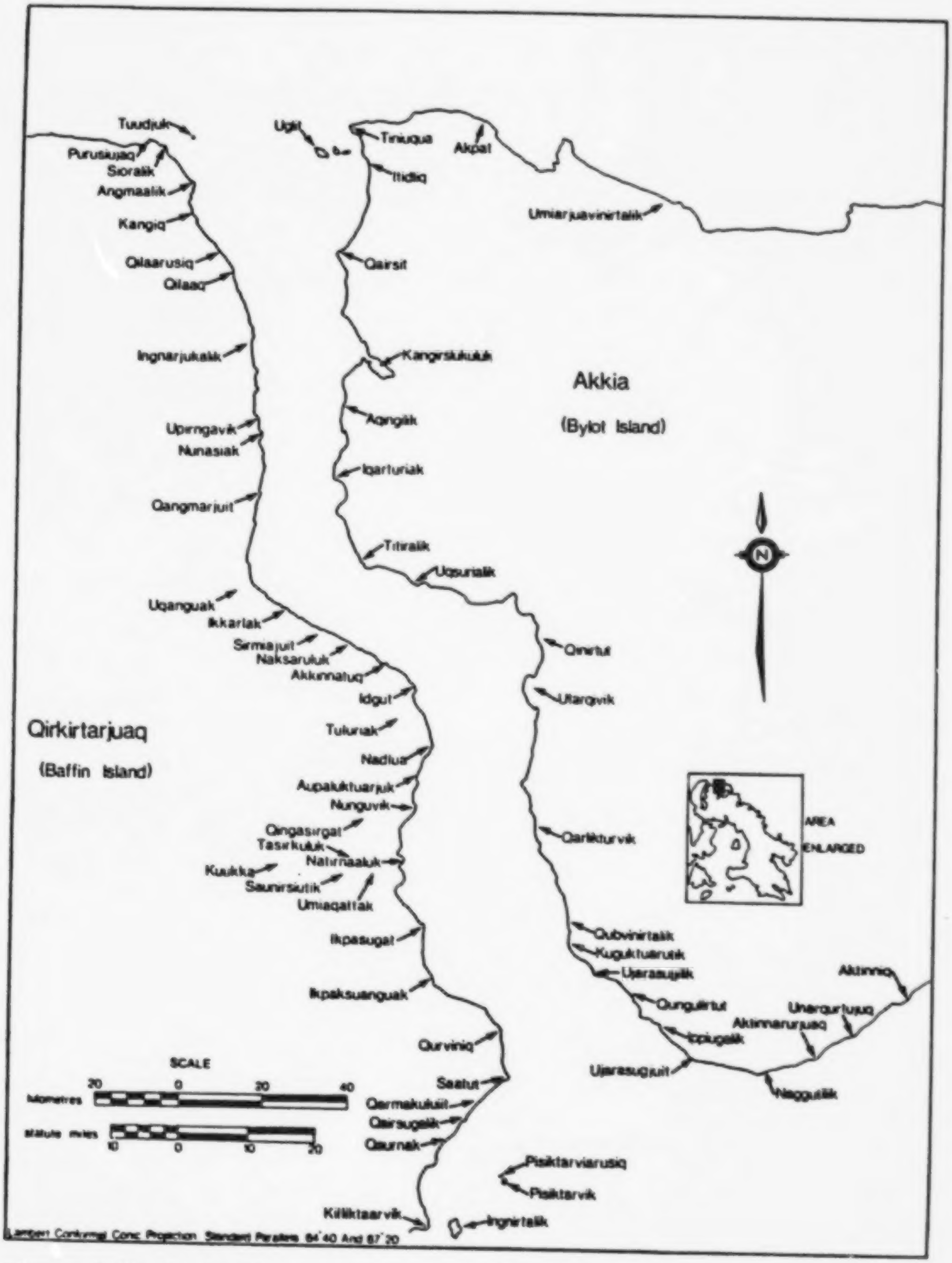

Tuudjuk
Ugjit
Tiniuqua
Akpat
Purusiujaq
Sioralik
Angmaalik
Itidliq
Kangiq
Umiarjuavinirtalik
Qilaarusiq
Qairsit
Qilaaq
Ingnarjukalik
Kangirsukuluk
Akkia
(Bylot Island)
Upirngavik
Aqngilik
Nunasiak
Iqarturiak
Qangmarjuit
Titiralik
Uqsurialik
N
Uqanguak
Ikkarlak
Sirmajuit
Naksaruluk
Qinirtut
Akkinnatuq
Idgut
Utarqvik
Qirkirtarjuaq
(Baffin Island)
Tuluriak
Nadlua
Aupaluktuarjuk
Nunguvik
Qingasirgat
Qarlikturvik
AREA
ENLARGED
Tasirkuluk
Natirnaaluk
Kuukka
Saunirsiutik
Umiaqattak
Ikpasugat
Qubvinirtalik
Kuguktuarutik
Ujarasugjilik
Aktinniq
Ikpaksuanguak
Qungulirtut
Unarqurluujuq
Aktinnarurjuaq
Ippiugalik
Qurviniq
SCALE
20
0
20
40
kilometres
Ujarasugjuit
Saatut
Naggutilik
Qarmakuluit
statute miles
Qairsugalik
10
0
10
20
Qaurnak
Pisiktarviarusiq
Pisiktarvik
Killiktaarvik
Ingnirtalik
Lambert Conformal Conic Projection Standard Parallels 64°40 And 67°20

**Figure 2.83** Inuit Place names in Navy BoardInlet (Milton Freeman Research Limited, 1976).

European penetration of the arctic. Aside from infrequent contacts with explorers and a small amount of European trade goods that reached them from the south, they remained independent of the European influence until the nineteenth century.

### 2.11.2 Modern History - Exploration

It was not until the 16th century, with European seafarers trying to find a passage to the riches of the Orient, that maps and records of the region were available. Exploration of the eastern Arctic took place over several centuries, beginning with John Cabot in 1498 and continued by other eminent explorers such as John Davis (1585), Martin Frobisher (1576), Robert Bylot and William Baffin (1616), William Parry (1821), and John Ross (1818 and 1835). The earlier expeditions were restricted to the southern waters of Baffin Bay and Davis Strait. John Cabot perished in the waters of Hudson Strait after being trapped in the ice. Martin Frobisher on his first expedition discovered the large inland bay on southern Baffin Island which is now named after him. It was not until the voyage of Bylot and Baffin in 1616 that the first reference to the Lancaster Sound region was made. Following the west coast of Greenland north into Baffin Bay, Bylot and Baffin discovered three great sounds which they named after Sir Thomas Smith, Alderman Jones and Sir James Lancaster (CMO, 1983). William Baffin's account of the voyage is well documented:

> "On the twelfth day (July 12, 1616) we were open of another great Sound, lying in the latitude of 74 degrees 20 minutes, and we called it Sir James Lankasters Sound; here our hope of passage began to be lesse every day than other, for from this Sound to the Southward we had a ledge of Ice between the Shoare and us, but cleare to the Seaward, we kept by this ledge of ice till the fourteenth day ..." (Purchas 1906).

Unable to proceed further into Lancaster Sound because of the ice, the expedition returned to England where Baffin and Bylots' discoveries were discredited by their contemporaries and forgotten. It was not until the voyage of John Ross in 1818 that the area was rediscovered and Bylot and Baffin were vindicated. Ross sailed into Lancaster Sound on August 30, 1818, but after 50 miles he believed his way blocked and proceeded no further (CMO, 1983). In his descriptions of the region, Ross made record of the waterway at the north end of Baffin Island calling it "Ponds Inlet" (Milton Freeman, 1976). The voyage by William Parry in 1821 made it through Lancaster Sound as far west as McClure Strait (113°48"W) where it was stopped by ice. Parry returned to England without finding the prized "Northwest Passage".

Though they were unsuccessful in finding a Northwest Passage, the voyages of Ross and Parry laid the foundation for the next 150 years of exploration in the Lancaster Sound area.

The most important of these expeditions in terms of the advancement of knowledge of the eastern Canadian arctic was the ill-fated Franklin expedition. The John Franklin expedition left England on May 19, 1845 with a party of 130 officers and men in search of the Northwest Passage, entered Lancaster Sound and disappeared. Between 1847 and 1859, forty expeditions wree organized to find the missing men. The more important of these expeditions are discussed.

In 1848 James Clark Ross, son of John Ross, led an expedition into Lancaster Sound. He stopped at Pond Inlet in August of that year to ask the help of the local Inuit. His journeys continued into Lancaster Sound that same year where his ships the "Investigator" and "Enterprise" became ice bound and drifted back into Baffin Bay near the northeast shore of Bylot Island.

In 1850 the "Advance" and the "Rescue" of the U.S. Grinnell expedition under Edwin J. Dehaven traveled into Lancaster Sound, became ice bound to the west of Devon Island and drifted northward with the ice into Wellington Channel. They spent nine months in the ice until finally being carried south and east and released in Davis Strait. The records of the Grinnel expedition include numerous accounts of the ice and meteorological data (CMO, 1983).

The Austin expedition of 1850-51 was equipped for three years of arctic exploration. The four vessels searched for Franklin through Lancaster Sound, Barrow Strait and westward beyond Winter Harbour on Melville Island.

William Penny, an arctic fur trader, also set out in 1850 to search for Franklin. He sailed up Lancaster Sound and explored the shorelines of western Devon Island and north into Wellington Channel. There are records of Penny using the area around Cape Hay on the north side of Bylot Island as a food cache during his voyages (Holland, 1970).

The largest of the Franklin search expeditions was led by Edward Belcher from 1852-1854. He searched through the southern waters of Lancaster Sound, along the shores of Bylot Island and then northwest into Wellington Channel where the two exploration ships the "Resolute" and "Intrepid" were abandoned to the ice. The H.M.S. "Resolute" was discovered sixteen months after she was abandoned, drifting off Cape Dyer along the southeastern shores of Baffin Island. During the Belcher expedition over 24,000 kilometers of sledging journeys were made throughout the Melville Island, McClure Strait, Banks Island and Prince of Wales Sound region (Belcher, 1855).

In 1853 Dr. Elisha Kent Kane led an American expedition in search of Franklin, exploring the area further north through Smith Sound, Kane Basin and Kennedy Channel to nearly 80 degrees north (Kane, 1856).

The 1853-54 expedition of Dr. John Rae resulted in the first information about the disappearance of the Franklin party, obtained from the Inuit (CMO, 1984).

Captain F.L. McClintock's expedition in 1857-58 sailed through Lancaster Sound and was caught in the ice of Bellot Strait in the winter of 1858. It was from here that extensive sledging journeys to King William Island were made which resulted in the discovery of the records from the Franklin expedition (McClintock, 1859).

With the return of McClintock to England the search for Franklin ended and subsequent expeditions to the arctic concentrated more on exploration and science. The more prominent of these are summarised below.

- The Hayes expedition of 1860 made extensive soundings, ice, water temperature, and meteorological observations in Baffin Bay.
- The Nares expedition of 1875 set out to explore the most northerly regions, and returned with extensive observations on polar oceanography, meterology, geology and biology.
- The Swedish "Sojia" expedition in 1885 collected water samples and temperature measurements in Lancaster Sound and Baffin Bay.
- The Danish "Flylla" expedition in 1884-1887 in Davis Strait.
- The collection of surface current data from sea ice observations in 1888-89 on the "Windward" expedition to northern Baffin Bay.
- The exploration of the arctic islands by Otto Sverdrup between 1898 and 1902.
- The first completed navigation of the Northwest Passage in 1906 by Roald Amundsen.
- The first Canadian sponsored expedition in 1903 under the command of geologist A.P. Low explored the waters of Smith and Lancaster sounds.
- Captain J.E. Bernier extended Low's explorations with four expeditions into the arctic islands early in the 20th century. His voyages through Lancaster Sound, Barrow Strait and Viscount Melville Sound provided extensive data on ice conditions, meteorology, geology, tides, currents, and biology.

Arctic expeditions continued throughout the first half of the 20th century with an ever increasing emphasis on the economic aspects of the region. Fur trading became a major industry in the eastern arctic. Mineral exploration was also being carried out within the arctic and 'Operation Franklin', a Canadian geological survey expedition which began in 1955, showed the first promise of hydrocarbon potential.

### 2.11.3 Early Commercial Activities

In spite of this exploration activity there was little exchange between the early European expeditions and the Inuit people of the area. It was the contact between the Dutch and Danish whalers in the early 19th century that had the greatest impact on local lifestyles. Throughout the 19th century European whalers exploited the resources of north and east Baffin Island. On their annual visits and occasional winterings around Pond Inlet and Eclipse Sound, they drew the majority of the population into trade and labour relationships. These relationships had a major impact on the lifestyle of the Inuit in that whalers paid with items of their southern material culture, most importantly, with guns and ammunition. The whalers also encouraged hunters to bring ivory and furs to trade, a demand that resulted in adjustments to traditional hunting patterns in order to supply the increased demands. The whalers' visits stopped early in the 20th century with the near extinction of the bowhead whale, by which time fur trading had been established within the region.

Whaling stations and trading posts were established at several sites within the Lancaster Sound/Eclipse Sound region (see Table 2.12 and Figure 2.84) from 1903 to 1921, when the Hudson's Bay Company established a permanent post at Pond Inlet. Another major Hudson's Bay post was established at Arctic Bay in 1936. A coal mine was opened at Salmon River in 1912 and operation by local Inuit continued until 1964. The Arctic Gold Exploration syndicate operated in the region from 1919 until 1923 with posts at Button Point, Albert Harbour and Pond Inlet, however, its activities were predominantly fur trading, see Table 2.12 and Figure 2.84.

**Table 2.12 Summary of Use and Occupancy of Sites which have Historic Value (After CMO 1983).**

| MAP NO. | SITE NAME | DATE | FUNCTION | OCCUPANT |
|---|---|---|---|---|
| 1 | Albert Harbour | 1903-9 | 4,5 | Robert Kinnes & Co. |
| | (Earjwack Station) | 1906-7 | 2 or 3 | J.-E Bernier |
| | | 1910 | 12 | J.-E Bernier |
| | | 1912-19 | 4 | J.-E Bernier |
| | | 1919-23 | 4 | Arctic Gold Explor. Synd. |
| | | 1923 | 4 | Hudson's Bay Company |
| 2 | Arctic Bay | 1908-09 | 2 or 3 | |
| | | 1910-11 | 2 or 3 | |
| | | 1926-7 | 4 | Hudson's Bay Company |
| | | 1936 | 4 | Hudson's Bay Company |
| | | 1937 | 8 | Anglican Church |
| | | ? | 8 | Roman Catholic Church |
| 3 | Assistance Bay | 1850-51 | 2 | Penny, John Ross |
| | | 1950-52 | 12 | Ommaney, Belcher |
| 4. | Batty Bay | 1832-3 | 1,18 | Ross |
| | | 1851-2 | 2 | Kennedy |
| 5 | Beechey Island | 1845-6 | 2,16 | Franklin |
| | | 1852-4 | 2,12,18 | Belcher |
| | | 1858 | 18 | M'Clintock |
| | | 1903 | 1 | Amundsen |
| | | 1908 | 12 | Bernier |
| 6 | Button Point | 1912 | 10 | Algernine |
| | | 1913-21 | 4 | Arctic Gold Expl. Synd. |
| 7 | Cape Hay | 1849 | 12 | Penny |
| 8 | Cape Hotham | 1850-4 | 12 | Ommanney, Belcher, et al |
| 9 | Cape Riley | 1845-6 | 1 | Franklin |
| | | 1853 | 10 | Breadalbane |
| 10 | Dundas Harbour | 1934-6 | 4 | Hudson's Bay Company (out post) |
| 11 | Fury Beach | 1825 | 10,12 | Parry, Fury |
| | | 1832-3 | 2,16 (no ship) | Ross |
| | | 1850's | 1,12 | Kennedy, Beelot, et al |
| 12 | Koroqdjuag | 1923-? | 4 | Hudson's Bay Company |
| 13 | Philpots Island | 1865 | 14 or 15 | Brown, Philpots |
| 14 | Pond Inlet | 1903 | 20 | Low |
| | (Mitimatilik Post) | 1912-19 | 4 | J.-E. Bernier |
| | | 1919-23 | 4 | Arctic Gold Expl. Synd. |
| | | 1921- | 4 | Hudson's Bay Company |
| | | 1922- | 7 | |
| | | 1927- | 8 | Anglican Church |
| | | 1929- | 8 | Roman Catholic Church |
| | | 1930 | 11 | |
| | | 1931 | 11 | |
| 15 | Port Bowen | 1824-5 | 2,16 | Parry |
| 16 | Port Leopold | 19th-20th C? | 5 | |
| | (Whaler Point; | 1848-9 | 2,12,16 | Ross |
| | Sikinik) | 1904 | 12 | Gjøa Exp. |
| | | 1906 | 12 | J.-E. Bernier |
| | | 1926-7 | 4 | Hudson's Bay Company |
| | | 1937-40 | 4 | Hudson's Bay Company |
| 17 | Salmon River | 1910-19 | 4 | J.-E. Bernier |
| | (Tuniaqtalik Point) | 1912?-1920? | 13 (coal) | |
| 18 | Tulukan | 1916-20 | 4 | R.Janes |
| 19 | Wollaston Islands | 1850 | 12 | Saunders |

1. Exploration camp - sledge
2. Wintering Harbour with shore facilities - exploration
3. Wintering Harbour - exploration
4. Trading Post
5. Whaling Station
6. Hospital
7. R.C.M.P. Post
8. Mission
9. Hunter' cabin; permanent
10. Shipwreck
11. Eskimo community
12. Food cache or depot
13. Mine
14. Wintering harbour with shore facilities - whaling
15. Wintering harbour whaling
16. Cemetary (non-native)
17. Pre-contact Inuit site
18. Commemorative Cairn
19. Ship's anchorage - non winter.

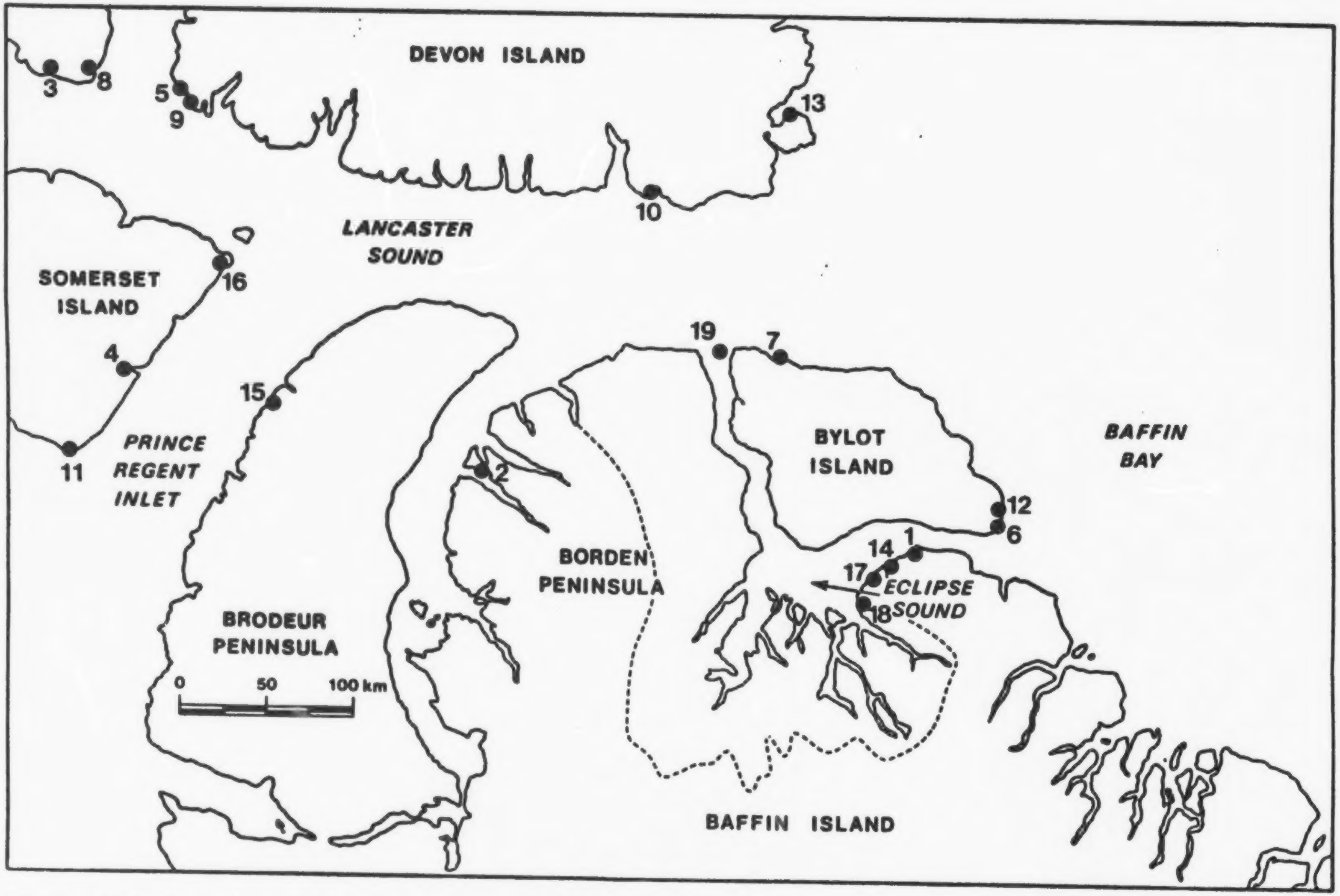

DEVON ISLAND
3
8
5
9
13
10
LANCASTER SOUND
SOMERSET ISLAND
16
4
15
11
PRINCE REGENT INLET
19
7
BYLOT ISLAND
BAFFIN BAY
12
6
2
14
1
17
ECLIPSE SOUND
18
BORDEN PENINSULA
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 2.84** Location of historic sites. Numbers correspond to description in Table 2.2 of this report.

### 2.11.4 Hunting Camps and Settlements

The Inuit people were traditionally nomadic in nature, and inhabited several different camps or settlements over the course of one to several years. Historically their camps were small and distributed over most of the Bylot Island and Eclipse Sound coastal region. They were located near places of good hunting and fishing and where shore access was easy. Before contact with whalers and fur traders, the Inuit travelled only to locate the best hunting and fishing sites to maintain a subsistance lifestyle.

With the advent of trade, longer journeys and increased migration took place in order to bring goods to the trading posts. Throughout the early 20th century the traditional semi-permanent camps of 2 to 12 families were maintained. However, increased dependence on the material items of the south slowly caused a migration of families to the centres of trade. By 1950 most of the small out-posts had been abandoned except for seasonal hunting camps (eg. the fishing camp at the head of Koluktoo Bay in Milne Inlet.) and the major population base was established at Pond Inlet (Figure 2.85). This abandonment of the traditional nomadic lifestyle of the Inuit was taking place over most of the eastern Arctic at this time, with other permanent communities being established at Arctic Bay, Grise Fjord and Resolute Bay. It is important to note that the site of the present community of Pond Inlet is located at a natural camping place. Archeological evidence suggests that is is among the most ancient Inuit campsites in the Canadian north.

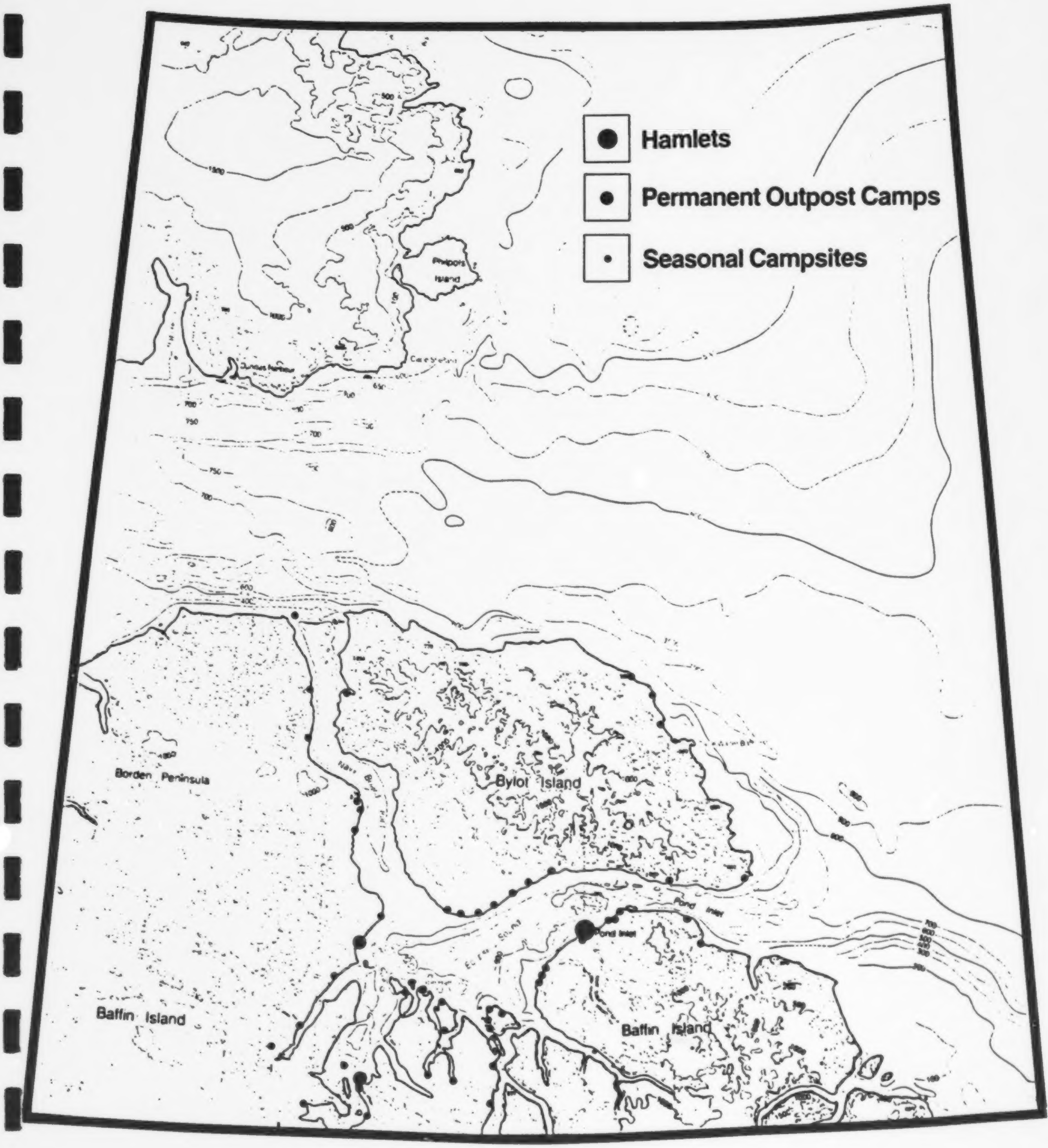

● Hamlets
● Permanent Outpost Camps
• Seasonal Campsites
Philpots Island
Dundas Harbour
Borden Peninsula
Bylot Island
Pond Inlet
Baffin Island
Baffin Island

Figure 2.85 Distribution of outposts and seasonal campsites (from D.I.A.N.D., 1982).

# 3.0 ASSESSMENT OF NATURALNESS

The Lancaster Sound/Eclipse Sound study area is predominantly in a natural state. Minor impacts and modifications to the environment by man have been restricted to early European explorations, whaling, fur trading and Inuit settlements. However, more efficient hunting techniques of local Inuit and increased use by non-local people, including some commercial enterprises such as mining and oil exploration, have occurred during the last ten years. Oil and gas exploration and production, mining and all associated support activities, are either proposed or are active in adjacent areas. Within the study area, impact from these activities to date has been largely restricted to transient shipping, research or geophysical ship activity within Lancaster Sound. Increased year-round shipping would itself create significant environmental impact.

## 3.1 INUIT LAND USE

Hunting and fishing by the Inuit people of the area has occurred throughout the recorded history of the region. This activity has included the taking of animals for both subsistence and trade. Several species are hunted within the marine environment and their distribution ranges over all of the study area. Seasonal hunting and fishing camps are located along most of the shorelines with their highest concentrations being within the Navy Board Inlet and Eclipse Sound areas. This activity has had little to no impact on the physical environment of the area. Camps are usually small (e.g. one or two families) and have few permananent structures. Many of these sites have been used for hundreds of years and are now considered to be areas of anthropologic importance.

The people from the community of Mittimatalik (Pond Inlet) on the south shore of Eclipse Sound have the greatest impact in the region, and to a lesser degree, the people from the community of Ikpiarjuk (Arctic Bay) along the west coast of the Borden Peninsula (Figure 3.1). People from Grise Fjord, on Ellesmere Island, conduct most activities in the Jones Sound region but utilize resources along the northern shore of Lancaster Sound.

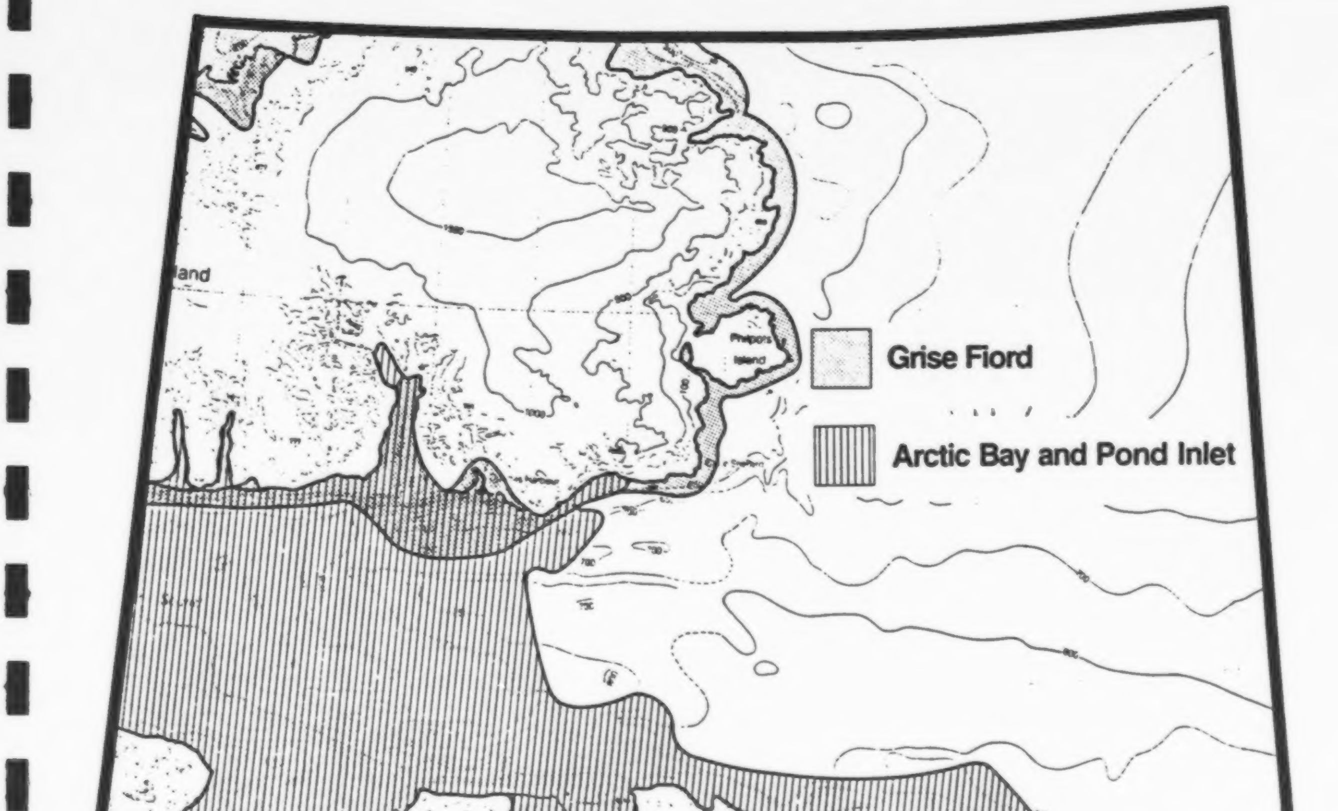

Grise Fiord
Arctic Bay and Pond Inlet
Bylot Island
Baffin Island
Pond Inlet
Baffin Island

**Figure 3.1** Extent of Inuit land use (from D.I.A.N.D., 1982).

The community of Pond Inlet, established in the early 20th century, supported a population of 660 people in 1981. Major facilities include a Hudson Bay Company store/trading post, R.C.M.P. detachment, Anglican and Catholic churches, hotel, school, nursing station, a recently constructed Co-op, airport, permanent housing and other related support structures. Arctic Bay was established as a permanent community in 1936 with the construction of a Hudson Bay trading post. Today the community has a R.C.M.P. detachment, Anglican and Catholic churches, schools and permanent housing. In 1976, the mining community of Nanisivik was established nearby and in 1978 a road link 24 kilometers long was completed between the two communities. It is likely, due to the increased activity in this portion of the arctic, that the communities of Pond Inlet and Arctic Bay will continue to expand.

An increased demand for material items from the south has shifted the former, predominately subsistence lifestyle of the Inuit to one of trade and, more recently, to wage employment. Increased acquisition of snowmobiles, boats and outboard motors have dramatically affected the hunting range and efficiency of the Inuit hunter.

Increased trade over the years has resulted in escalated hunting of "cash" animals, predominantly the fur bearing animals (e.g. polar bear, fox and seals) and whales (e.g. narwhal). Quotas have been placed on several of these species in order to control this hunting. The polar bear quota for 1979-1980 was 15 animals, worth about $16,000. The sale of narwhal ivory brought an estimated $46,000 to Pond Inlet hunters in 1979. By 1981 the price of ivory and resulting income had doubled (CMO, 1983), but both have declined recently due to new international restrictions on ivory trading. Nevertheless, this increased hunting due to monetary demands and technological developments in hunting practices are placing an increasing strain on wildlife populations and therefore on the naturalness of the region.

### 3.1.1 Hunting and Fishing

It is not possible to delineate the precise extent of the Inuit hunting and fishing areas. Animals migrate and are not confined to the same areas on a seasonal or even yearly basis. Summary evaluations of hunting and fishing data over several years on the dominant species in the study area provide the best representation of this use. This component of the economy, for Pond Inlet and Arctic Bay, is based primarily on marine wildlife. The principal species hunted include polar bears, walrus, ringed seals, bearded seals and narwhals. Species hunted secondarily, on an opportunistic basis, are harp seals, hooded seals and beluga whales. In addition waterfowl, caribou and arctic fox are taken along coastal regions. Arctic char is the dominant fish taken, with secondary catches of cod and sculpins.

Table 3.1 shows a summary of estimated harvests of marine animals taken by Pond Inlet and Arctic Bay hunters over a ten year period during 1973 - 1982. The period throughout the year during which each animal species is hunted is dependant upon several factors. The most prominant of these are seasonal migration patterns of the animals, access to hunting grounds and the needs of the Inuit for a particular animal species. The overlap of seasonal hunting and fishing periods for the Pond Inlet and Arctic Bay people is as follows:

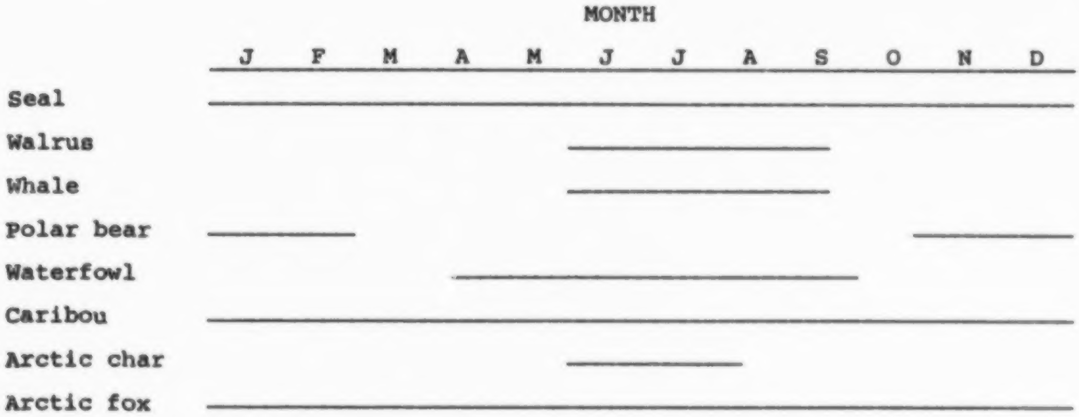


**Table 3.1 Summary of estimated harvests of marine animals taken by Pond Inlet and Arctic Bay Hunters.**

| SPECIES | POND INLET | ARCTIC BAY |
|---|---|---|
| Ringed seal | 892.8 (9) | 813.9 (10) |
| Harp seal | 16.3 (8) | 2950.0 (9) |
| Other seal | 193.5 (8) | 145.4 (9) |
| Walrus | 4.6 (8) | 3.4 (7) |
| Narwhal | 113.6 (9) | 85.3 (10) |
| Beluga | 1.17 (6) | 6 (5) |

NOTE: The numbers indicate the harvest average during 1973 - 1982 ignoring all years with information blanks. The number of years of data for each species is included in brackets (i.e., an average of 1.17 beluga over 6 years taken by Pond Inlet hunters). (DFO, 1983).

Seals are hunted year-round in Navy Board Inlet, Eclipse Sound, Pond Inlet and along the eastern coasts of Bylot Island and Baffin Bay (Figure 3.2). Seal hunting is heaviest in spring, summer and fall. However hunting on the ice along recurrent cracks or at breathing holes is done all winter. In the spring seals are taken where they bask on the ice, along floe edges, and during the summer, they are hunted in open water. The number of seals taken is partly a function of the market price of the pelts. About 2,500 seals were taken by Pond Inlet hunters in 1979, however, the ten year average between 1973 - 1982 was 1102 seals.

Walruses are hunted in most of the inland waters of Navy Board Inlet and Pond Inlet and on the ice floe edges of Lancaster Sound along the coast of Bylot Island and Borden Peninsula (Figure 3.3). The animals are hunted mainly in the late spring when they appear at ice floe edges. In the summer they are hunted frequently from boats when encountered in open water or at hauling-out places. A major hunting site for Pond Inlet people is on Wollaston Island at the mouth of Navy Board Inlet. The walrus ivory is used for carving and some of the meat for food.

Whale hunting, (Figure 3.4) is carried out in most of Navy Board Inlet, Pond Inlet and the Eclipse Sound area throughout the summer and along ice floe edges during the spring. The species taken most often is the narwhal, due to the high commercial value of the tusks, but beluga are also hunted whenever possible. Hunting along the ice edge occurs near the entrances of Pond Inlet and Navy Board Inlet in June and early July and in leads and cracks as the whales enter inland waters during the ice breakup. Hunting from boats occurs in most of Eclipse Sound and Navy Board Inlet until the fall freezeup.

Polar bear hunting occurs over most of the marine and coastal areas of the Bylot Island/Eclipse Sound region (Figure 3.5). Bears are hunted primarily in late winter. They are commonly taken along the floe edges at the entrances of Pond Inlet and Navy Board Inlet and on the land-fast ice along most of the coast line of northern Baffin Island and Bylot Island. A major hunting region for Pond Inlet hunters is along the northern coast of Bylot Island.

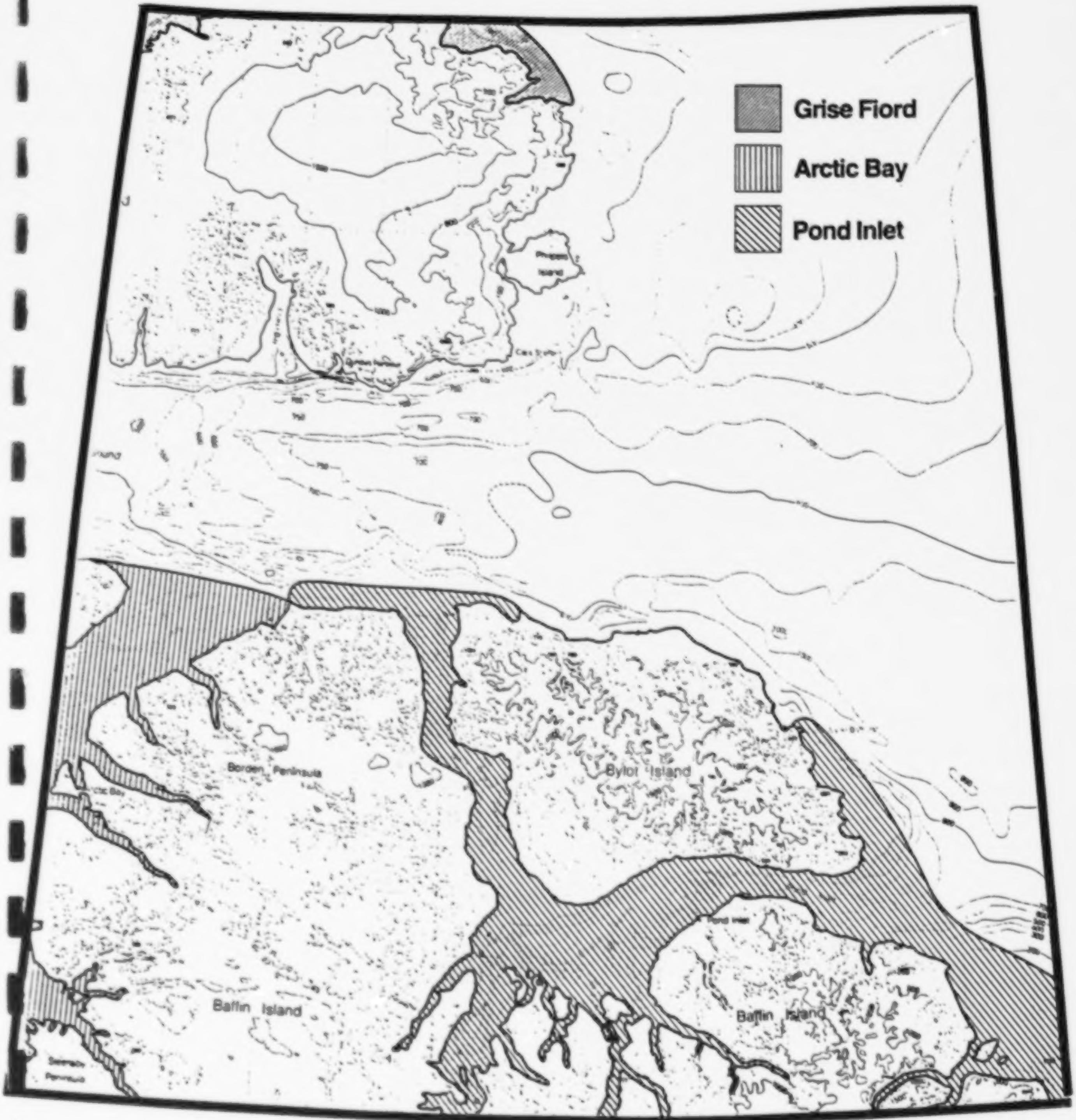

Grise Fiord
Arctic Bay
Pond Inlet
Philpots Island
Borden Peninsula
Arctic Bay
Bylot Island
Pond Inlet
Baffin Island
Baffin Island

Figure 3.2  Distribution of Inuit seal hunting (from D.I.A.N.D., 1982).

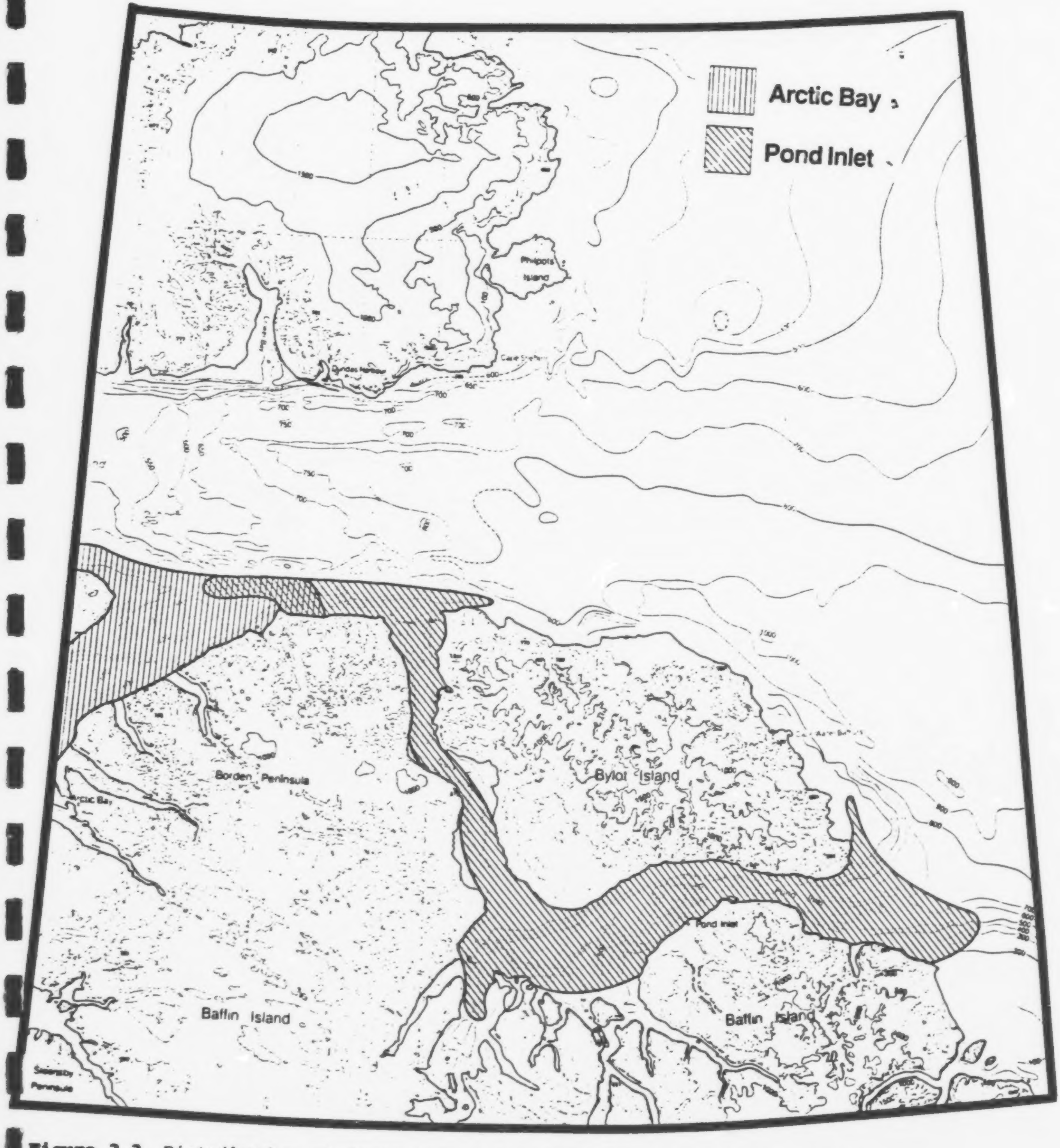

▥ Arctic Bay
▨ Pond Inlet
Philpots Island
Croker Bay
Dundas Harbour
Cape Sherard
Borden Peninsula
Arctic Bay
Bylot Island
Pond Inlet
Baffin Island
Baffin Island

Figure 3.3 Distribution of Inuit walrus hunting (from D.I.A.N.D., 1982).

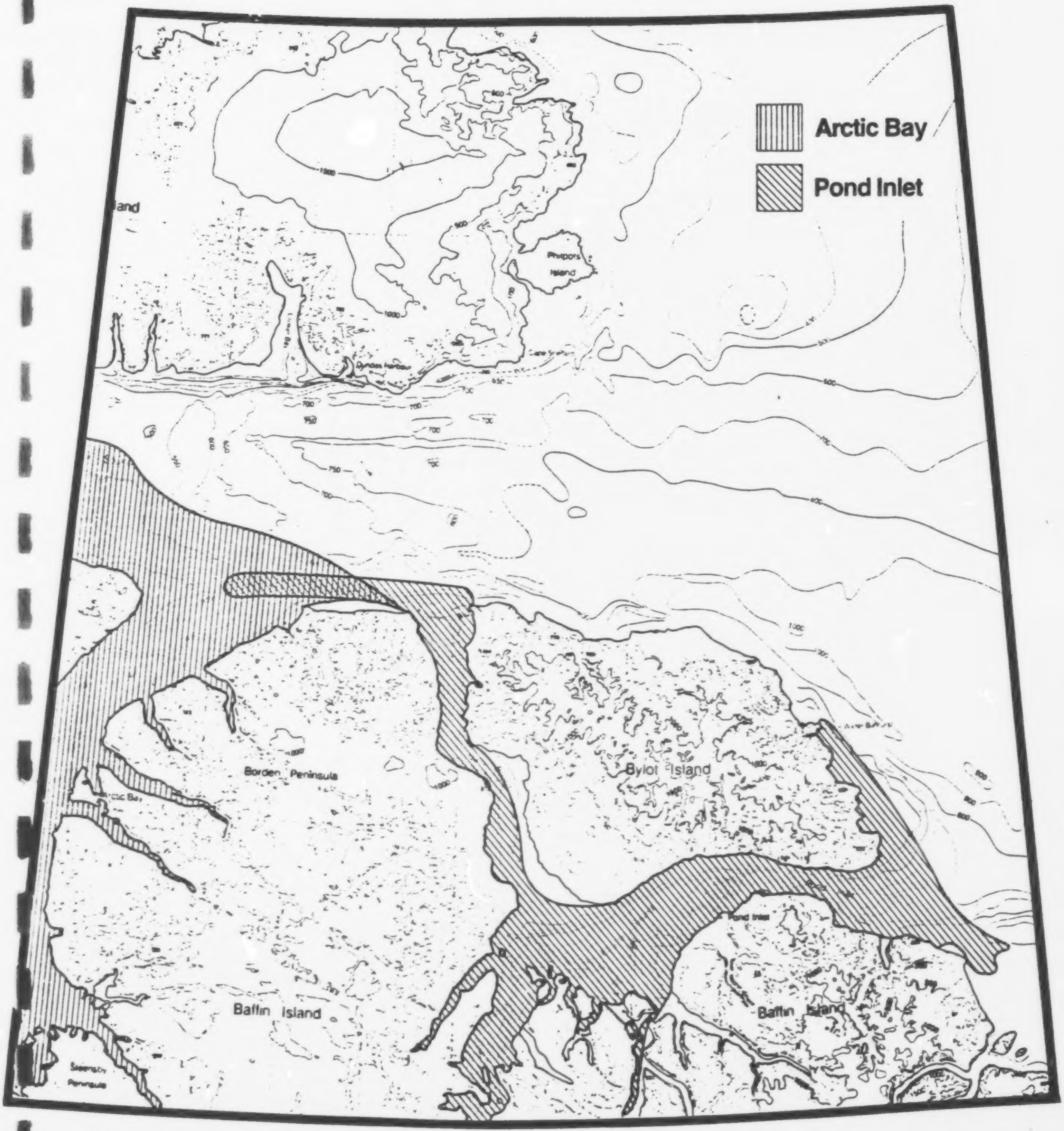

Arctic Bay
Pond Inlet
Philpots Island
Dundas Harbour
Borden Peninsula
Bylot Island
Arctic Bay
Pond Inlet
Baffin Island
Baffin Island
Steensby Peninsula

Figure 3.4 Distribution of Inuit whale hunting (from D.I.A.N.D., 1982).

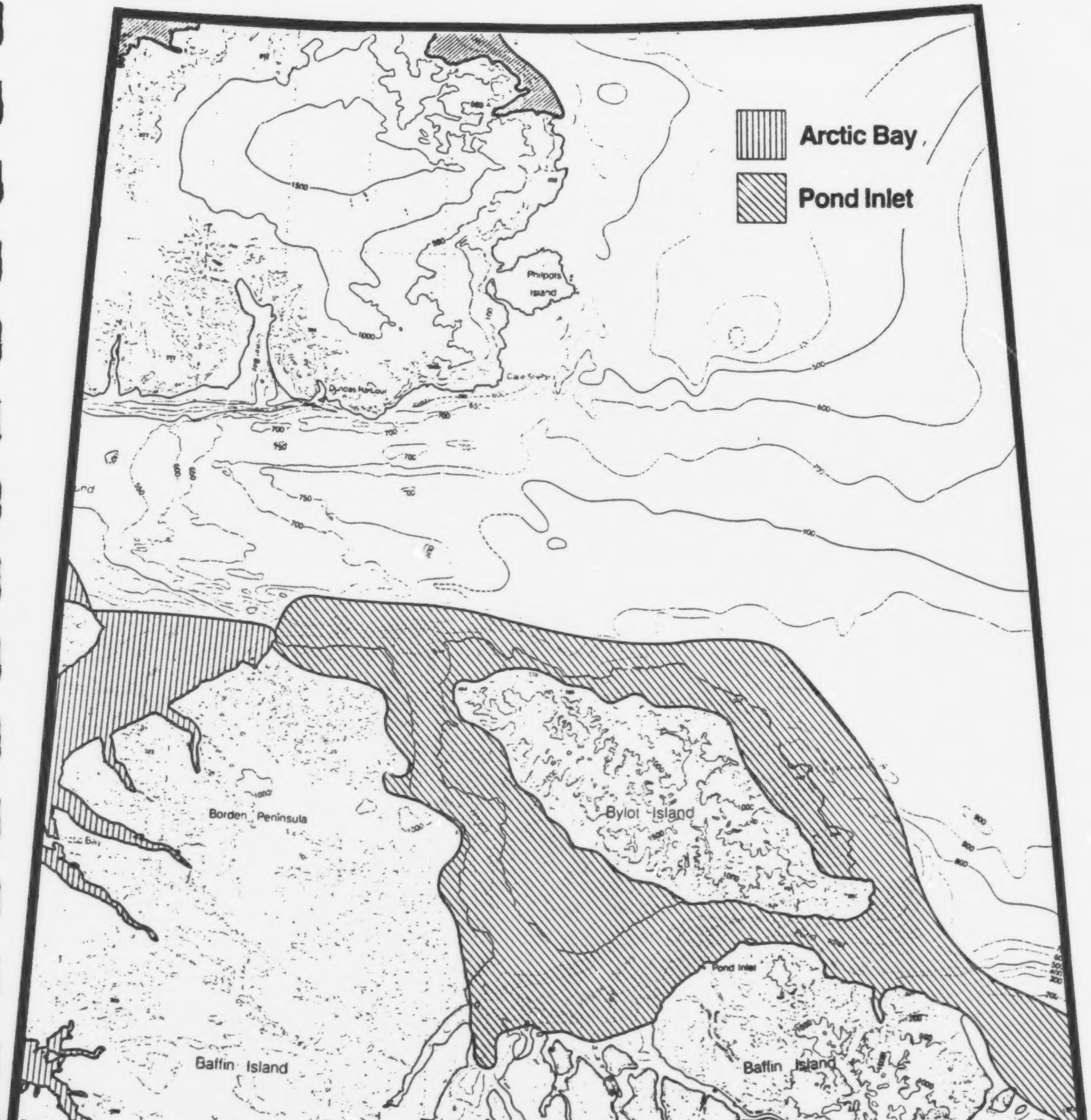

Arctic Bay
Pond Inlet
Philpots Island
Dundas Harbour
Borden Peninsula
Bylot Island
Pond Inlet
Baffin Island
Baffin Island
Arctic Bay
Steensby Peninsula

Figure 3.5 Distribution of Inuit polar bear hunting (from D.I.A.N.D., 1982).

Waterfowl are hunted throughout the spring, summer and fall. They are taken at many locations, on the water, along coastal areas and along floe edges, depending on the time of year (Figure 3.6). The coasts of Navy Board Inlet are the favoured goose hunting areas for Pond Inlet residents. Ducks are also taken along these coastal regions, usually in conjunction with goose hunting, and along ice floe edges in the spring. Major duck hunting areas are found along the shore both northeast and southwest of the community of Pond Inlet, and to a lesser extent in Tay Sound and Milne Inlet. Eggs of most waterfowl species are taken at the nesting sites in late spring and summer. During hunting excursions for other animals, Inuit also take other birds, such as Ptarmigan and seabirds, to supplement their diet.

Fishing occurs predominantly within the inland waters of Eclipse Sound and Pond Inlet (Figure 3.7). Arctic char is the most important species taken, with cod and sculpins being of secondary importance. Fishing for lake trout and landlocked char is also important in coastal rivers and lakes.

Fishing patterns are variable and are related to the species, time of year and location. The majority of fishing occurs from late spring to mid-summer. During the open water period, nets are set at river mouths and along shorelines, while fall and winter fishing is restricted to holes through lake ice. One of the major fishing areas for Pond Inlet residents is in Koluktoo Bay at the head of Milne Inlet. This is also the site of a summer facility for guided fishing charters.

Trap lines are set along most of the coastal areas and in shore-fast ice of the study region (Figure 3.8). The most important species taken is the arctic fox, which contributes significantly to the economy of the region. The most intensive trapping occurs in Pond Inlet, Eclipse Sound, southern Navy Board Inlet and along eastern Bylot Island. Arctic fox trapping is important as a source of income. The number of pelts taken is highly variable, depending on market price and population cycles. From 1957 to 1967 an average of 550 pelts were traded per year, with a peak of 1365. However, in 1979 only 157 foxes were estimated to have been taken by Pond Inlet trappers.

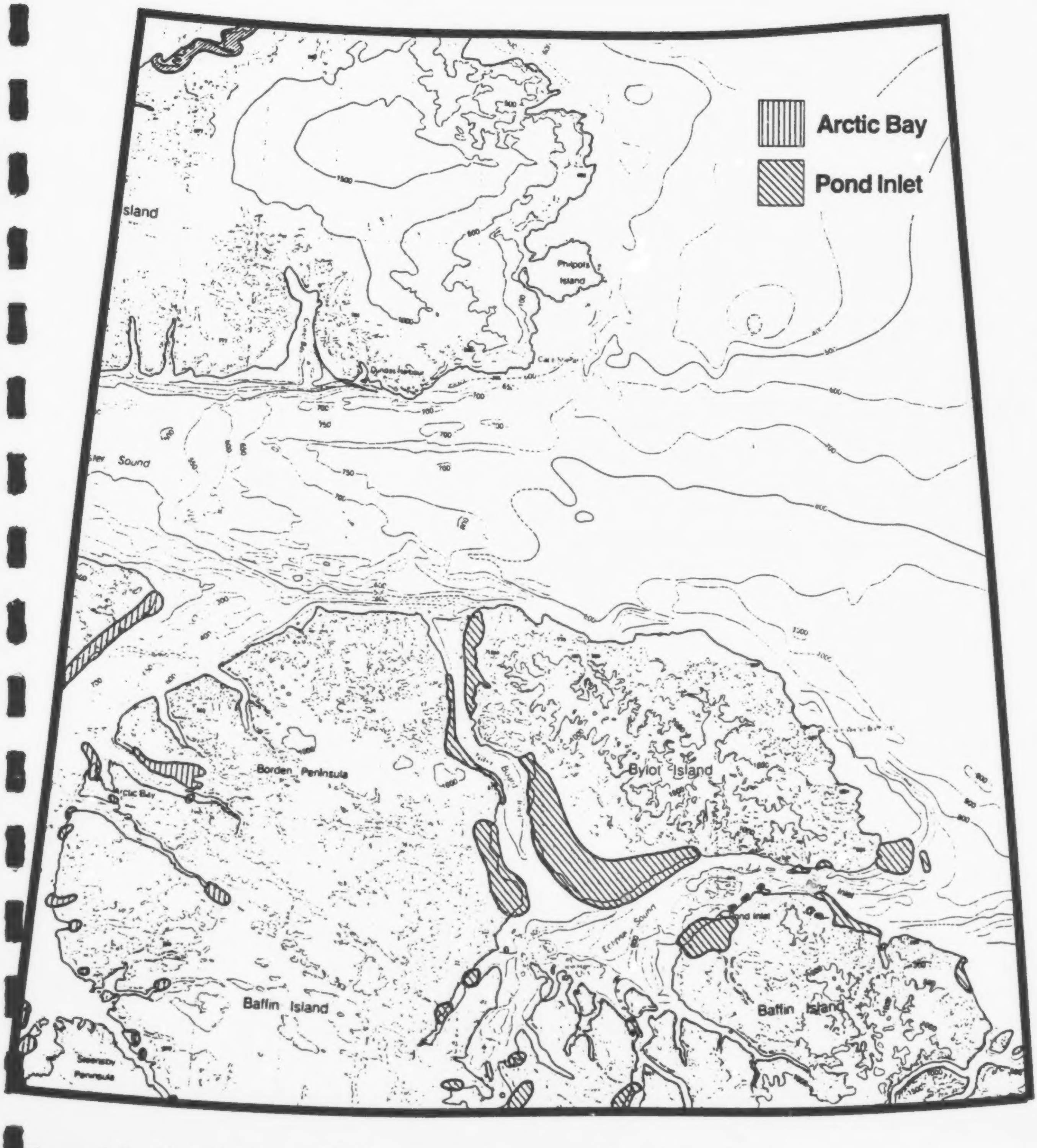

Arctic Bay
Pond Inlet
Island
Philpots Island
Dundas Harbour
Lancaster Sound
Borden Peninsula
Arctic Bay
Bylot Island
Pond Inlet
Eclipse Sound
Baffin Island
Baffin Island
Steensby Peninsula

Figure 3.6 Distribution of Inuit waterfowl hunting (from D.I.A.N.D., 1982).

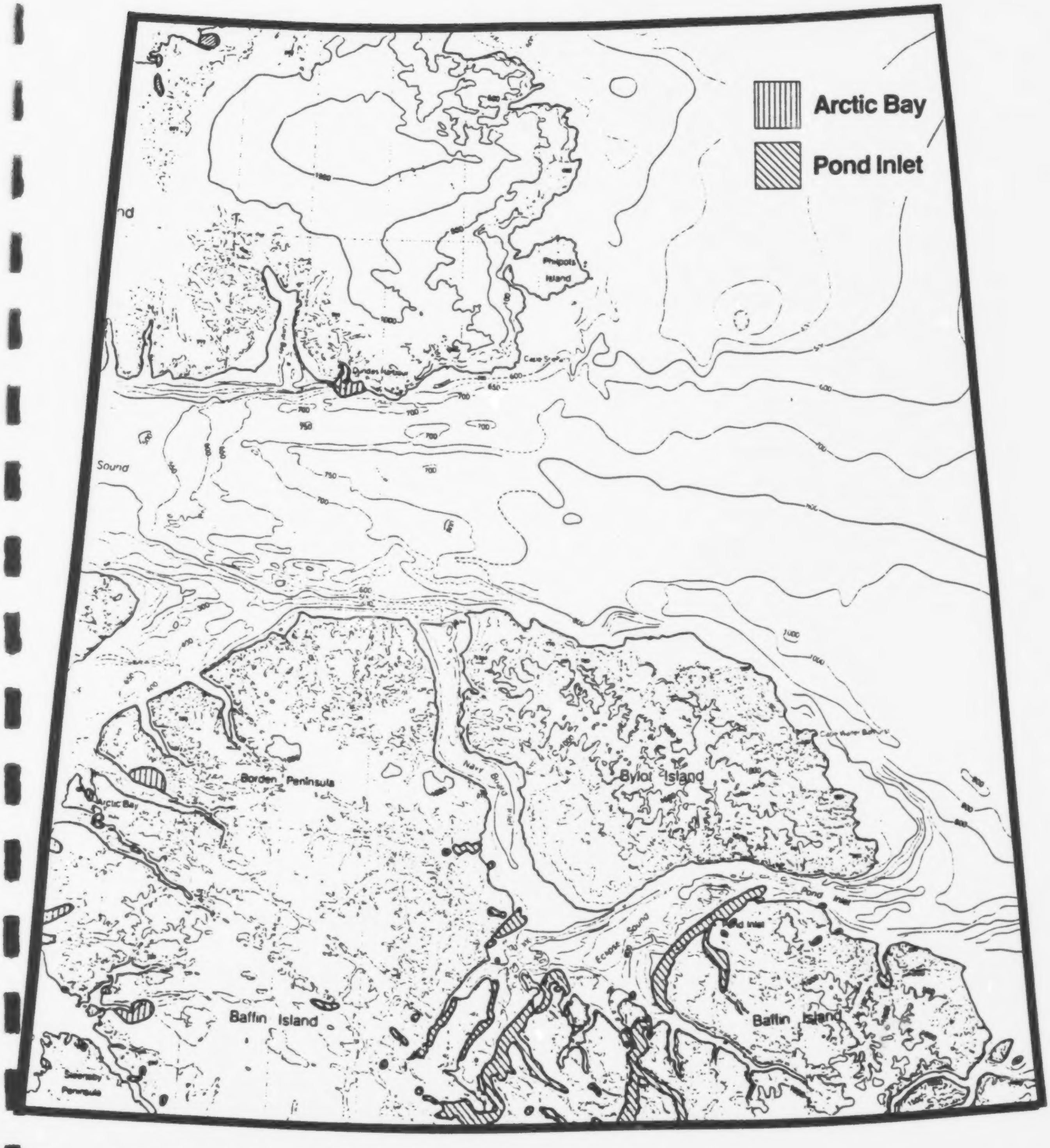

Arctic Bay
Pond Inlet
Philpots Island
Dundas Harbour
Sound
Borden Peninsula
Bylot Island
Arctic Bay
Navy Board Inlet
Eclipse Sound
Pond Inlet
Pond Inlet
Baffin Island
Baffin Island

Figure 3.7 Distribution of Inuit fishing (from D.I.A.N.D., 1982).

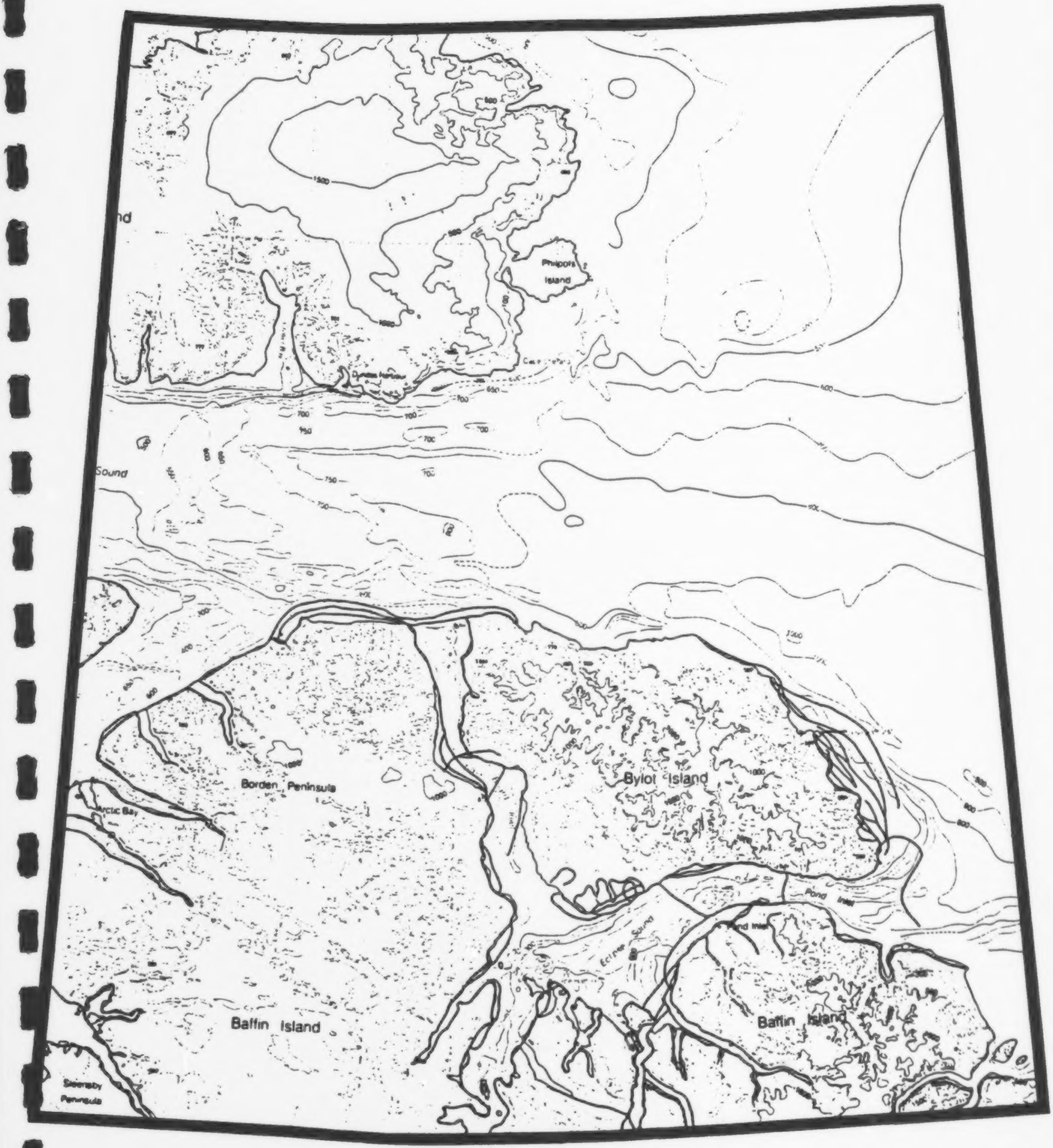

1500
Philpots Island
Dundas Harbour
nd
Sound
700
750
Borden Peninsula
Arctic Bay
Bylot Island
Pond Inlet
Eclipse Sound
Baffin Island
Baffin Island
Steensby Peninsula

Figure 3.8 Distribution of Inuit traplines. Shown by solid lines around shoreline of Bylot Island and Eclipse Sound (from D.I.A.N.D., 1982).

Caribou is the principal non-marine animal hunted within the area. They are hunted primarily south of Eclipse Sound and around Milne Inlet (Figure 3.9). Hunting is generally done inland during the winter and in coastal regions during the summer and fall.

## 3.2 NON-INUIT USE

Recent non-Inuit use of the Lancaster Sound/Eclipse Sound region has been restricted primarily to transient shipping, research and preliminary oil and gas exploration. The area of greatest use to date has been Lancaster Sound itself, which forms the major east-west shipping corridor through the eastern Arctic. Interest in the potential oil, gas and mineral reserves of the Lancaster Sound region is also high.

Future exploration and development of these non-renewable resources is a primary issue with the Inuit, industry and governments of Canada. The DINA green paper (1982) discusses the options for future uses within the Lancaster Sound region as ranging from strict environmental protection to concerted economic development.

The potential impact of non-Inuit uses within the study area can be described in terms of (a) impact upon naturalness from regular use activities (e.g. construction of coastal support facilities) and (b) impact upon naturalness from accident (e.g. an oil spill). At this time, most activities are still in the planning stage. Detailed analyses of impact are difficult to make until each activity is more clearly defined. Generalizations can be made, however, and give a good understanding of some of the potential problems.

The following discussions outline the present non-Inuit use of the study area and the potential for future development of the non-renewable resources, and their effects on the naturalness of the Lancaster Sound/ Eclipse Sound region.

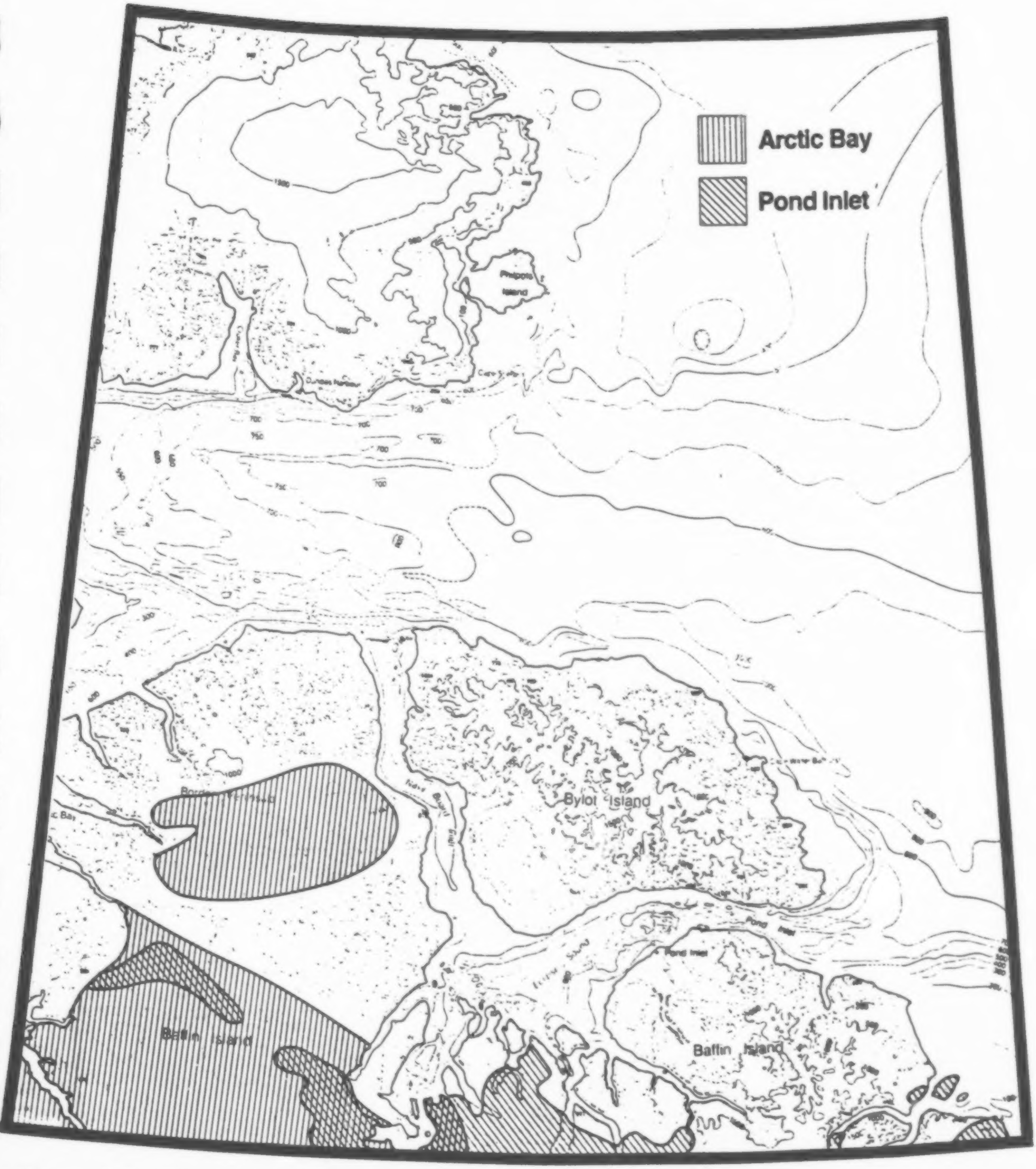

▥ Arctic Bay
▨ Pond Inlet
Philpots Island
Bylot Island
Baffin Island
Baffin Island
Pond Inlet

**Figure 3.9** Distribution of Inuit caribou hunting (from D.I.A.N.D., 1982).

### 3.2.1 Shipping

Shipping is the major non-Inuit use of the study area. There are four shipping routes through the Arctic archipelago collectively called the "Northwest Passage", and Lancaster Sound is common to all four routes. The major activities are (a) the shipments of lead and zinc concentrates from Strathcona Sound (Nanisivik mines) and Little Cornwallis Island (Polaris Mines) for Europe and (b) the annual resupply of communities located in the area, see Figure 3.10. The number of ships using these shipping corridors is small, but activity has been increasing over the last few years. In 1979 a total of 23 ships transited through Lancaster Sound including eight resupply vessels, six ore shipments from the Nanisivik mine site and seven Government ships (DIAND, 1982). Supply ships and ore-carriers are often accompanied by Canadian Coast Guard ice breakers. In 1980 activity increased with the construction of the Arvik mine on Little Cornwallis Island and the subsequent addition of new ore shipments east through Lancaster Sound. At present there are about 80 ship transits each year servicing both the communities and mining operations in the region.

Recently, shipping activities have included the first shipment of oil from the Benthorn field on Cameron Island, the visits of tour vessels to the area in the summers of 1984 and 1985 and, in August 1985, the U.S. Coast Guard ice breaker Polar Sea transited the Northwest Passage. The latter of these has prompted a Canadian federal cabinet decision to proceed with the construction of Canadian polar icebreaker.

There is a high potential for future increases in shipping through Lancaster Sound. Official and unofficial proposals for year-round transportation of bulk oil and LNG by means of arctic class tankers include the following:

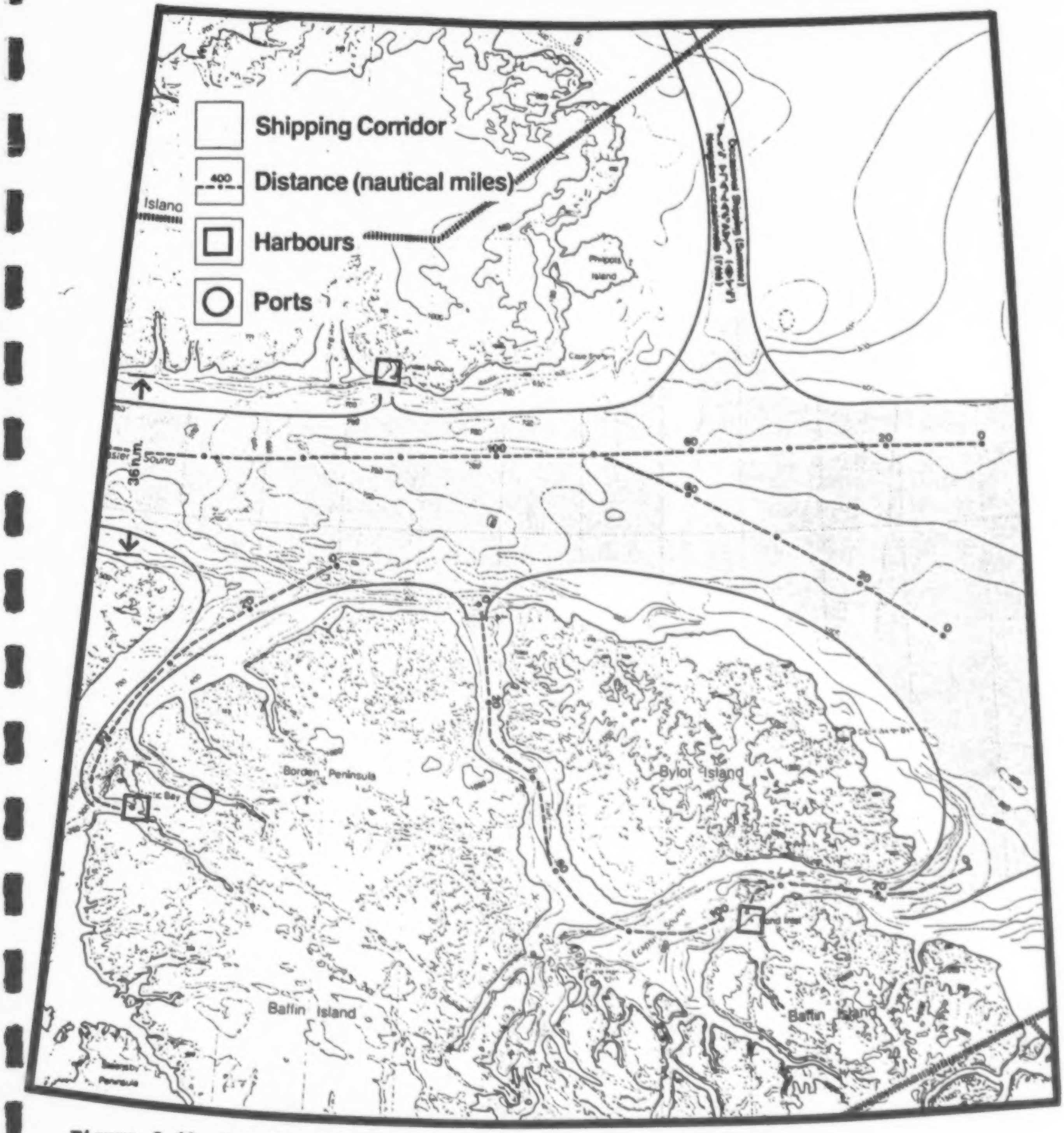

Shipping Corridor
400
Distance (nautical miles)
Harbours
Ports
Island
Philpots Island
2
100
60
20
0
36 n.m.
Sound
40
20
0
20
Borden Peninsula
Bylot Island
Baffin Island
Baffin Island
Eclipse Sound
100
20

Figure 3.10 Present shipping corridors (summer only), (from D.I.A.N.D.,1982).

a) Arctic Pilot Project: Year-round transportation of LNG from Bridport Inlet, N.W.T. to an eastern Canadian LNG terminal. The proposal includes two 140,000 cubic meter capacity arctic class 7 LNG carriers, each carrier to make 13 round trips per year (D.I.A.N.D., 1982).

b) Dome Petroleum Limited: Year-round transportation of bulk oil from a Beaufort Sea terminal east through the North West Passage to Atlantic terminals. The number of tankers and number of yearly trips is not known (D.I.A.N.D., 1982).

c) Globtik Tankers: Year-round transportation of bulk oil from northern Alaska to Conception Bay, Newfoundland via Lancaster Sound by arctic class tankers. The number of ships or number of trips is not known (D.I.A.N.D., 1982).

d) U.S. Seatrain Lines: Year-round transportation of bulk oil from northern Alaska to a Long Island Sound terminal via Lancaster Sound by means of three arctic class tankers, each to make 15 round trips per year (D.I.A.N.D., 1982).

e) Panarctic Oil: Transportation of crude oil from the Benthorn field on Cameron Island to eastern Canadian terminals via Lancaster Sound.

Classification of this potential activity into low, medium and high categories results in tentative estimates of future shipping through Lancaster Sound (D.I.A.N.D., 1982) (see Table 3.2 and Figure 3.11).

Evaluations by Mansfield (1983) project even greater use of Lancaster Sound for year-round shipping. To fully exploit the potential of the gas reserves in the Sverdrup Basin and North Slope of Alaska as well as the oil reserves of the Beaufort Sea, it may be necessary to operate a total of 104 super-tankers on a year round basis. This would mean that a tanker will

**Table 3.2 Potential Shipping Activity In Lancaster Sound (D.I.A.N.D., 1983).**

| Activity | Number of Ships | | | |
|---|---|---|---|---|
| | 1990 | | 1995 | |
| Category | Summer | Winter | Summer | Winter |
| Low | 1 every 2 days | - | 1 every 2 days | - |
| Medium | 1 per day | 1 every 2 days | 1 per day | 1 every 2 days |
| High | 2 per day | 1 per day | 3 per day | 2 per day |

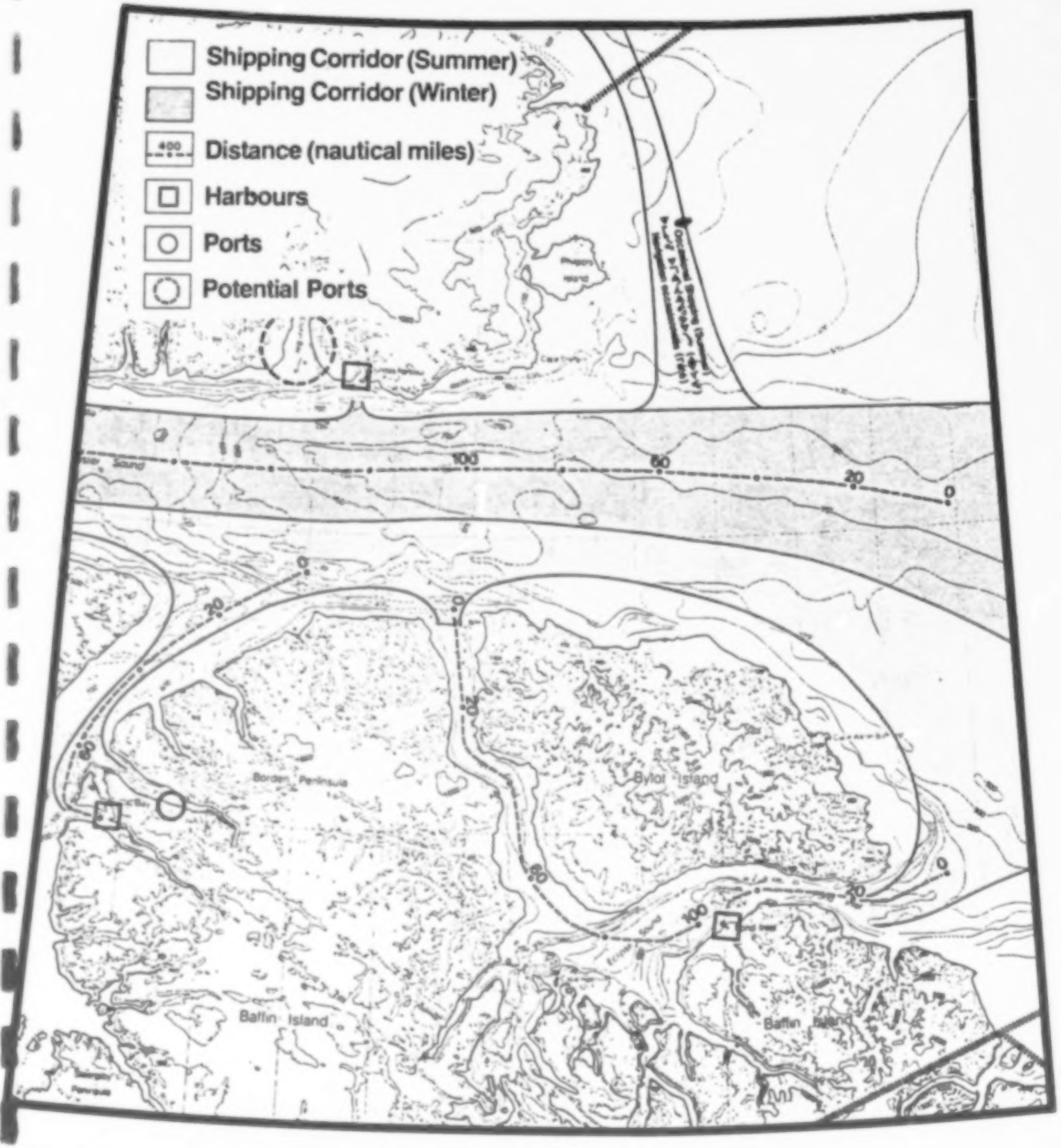

Shipping Corridor (Summer)
Shipping Corridor (Winter)
400
Distance (nautical miles)
Harbours
Ports
Potential Ports
Sound
100
60
20
0
0
20
0
20
60
Borden Peninsula
Bylot Island
60
100
20
0
Baffin Island
Baffin Island

Figure 3.11 Potential summer and winter shipping corridors (D.I.A.N.D., 1982).

pass any point on the route through Lancaster Sound every 2.3 to 5.5 hours, depending on the season. These estimates may be high based on more recent considerations in the petroleum industry. Tanker transportation of hydrocarbons from the western Arctic is becoming less likely as pipelines become, increasingly, the preferred alternative.

The impact of shipping at the present time is moderate, with the majority of ship transits ocurring during the open-water months. Proposed year-round shipping through Lancaster Sound will result in increased environmental impacts. The exact implications of more shipping are at present speculation; however, impacts are expected from the noise of ship traffic and from the continual breaking of routes through the ice of Lancaster Sound. These may include biological effects such as the disruption of the migration patterns of marine mammals and the feeding patterns of sea birds. This would be of particular importance if shipping routes were to follow the biologically important floe-edge through the northern part of the sound, as proposed. The impact on the ice itself may include changes in the lead patterns of the area and in the integrity of the ice arch in eastern Lancaster Sound. If ship traffic is not sufficient to maintain an open channel during the winter months, the formation of "traps" (hard-frozen old ship tracks) may necessitate regular breaking of new paths, resulting in a wider use of the sound. It would also be possible for whales to be trapped in refreezing ship tracks. In the spring months continuous ship traffic could result in unfrozen ship tracks which would interfere with inter-island crossings of caribou, arctic fox and Inuit hunters.

The potential for pollution from normal ship operations as well as from an oil tanker spill would increase with the number of ships. World-wide experience with risks inherent in tanker transport suggests that the projected level of shipping over the 20-year period could be expected to result in at least one major oil spill and possibly one LNG-fire, attributable to tanker accidents, somewhere in the Northwest Passage. The extent of oil spill damages would depend on the location of the accident, the amount of oil released, the season, the dispersion by wind and currents, the clean-up response time, and the capabilities of the clean-up equipment used.

Oil spills in winter would be initially restricted to the ship track, but residual oil would be distributed by winds and currents when ice cover broke and melted. A large oil spill in Lancaster Sound would be very serious biologically and would also have serious economic repercussions in the communities (D.I.N.A., 1982).

### 3.2.2 Oil Exploration

Oil and gas exploration activities in the Lancaster Sound region have been restricted to the research and planning stage. However, most of the seafloor of eastern Lancaster Sound and the continental margins of Devon Island, Bylot Island and Baffin Island within Baffin Bay are covered by oil and gas exploration permits (Figure 3.12). These permits cover most of the high-potential oil- and gas-bearing structures. It is expected that 50 wildcat exploratory wells would be needed to estimate the reserves and size of the structures.

The area of Lancaster Sound between Bylot Island and southeastern Devon Island has the highest potential for oil and gas discoveries in the eastern Arctic. A down-faulted block structure within Lancaster Sound has isolated a portion of the Paleozoic sedimentary strata which is concluded to be a prospective oil producing formation (Figure 3.13)(CMO, 1983). Within this area oil and gas anomalies have already been mapped, see Figure 3.14. CMO, a consortium of companies which holds the permit for part of this area has submitted a resource management plan for exploratory drilling within Lancaster Sound. The proposed location of the first exploratory well, Dundas K-56, is shown in Figure 3.15. Other companies which hold leases within the area are also considering exploration activities.

Consolidated-Magnorth-Oakwood (CMO) applied in 1976 to drill an exploratory well within Lancaster Sound; an expanded drilling program and production would follow if oil was discovered. The recommendations of the Environmental Assessment and Review Process panel (EARP) in 1978 led to an on-going deferral of the program. The EARP Panel recommended that a

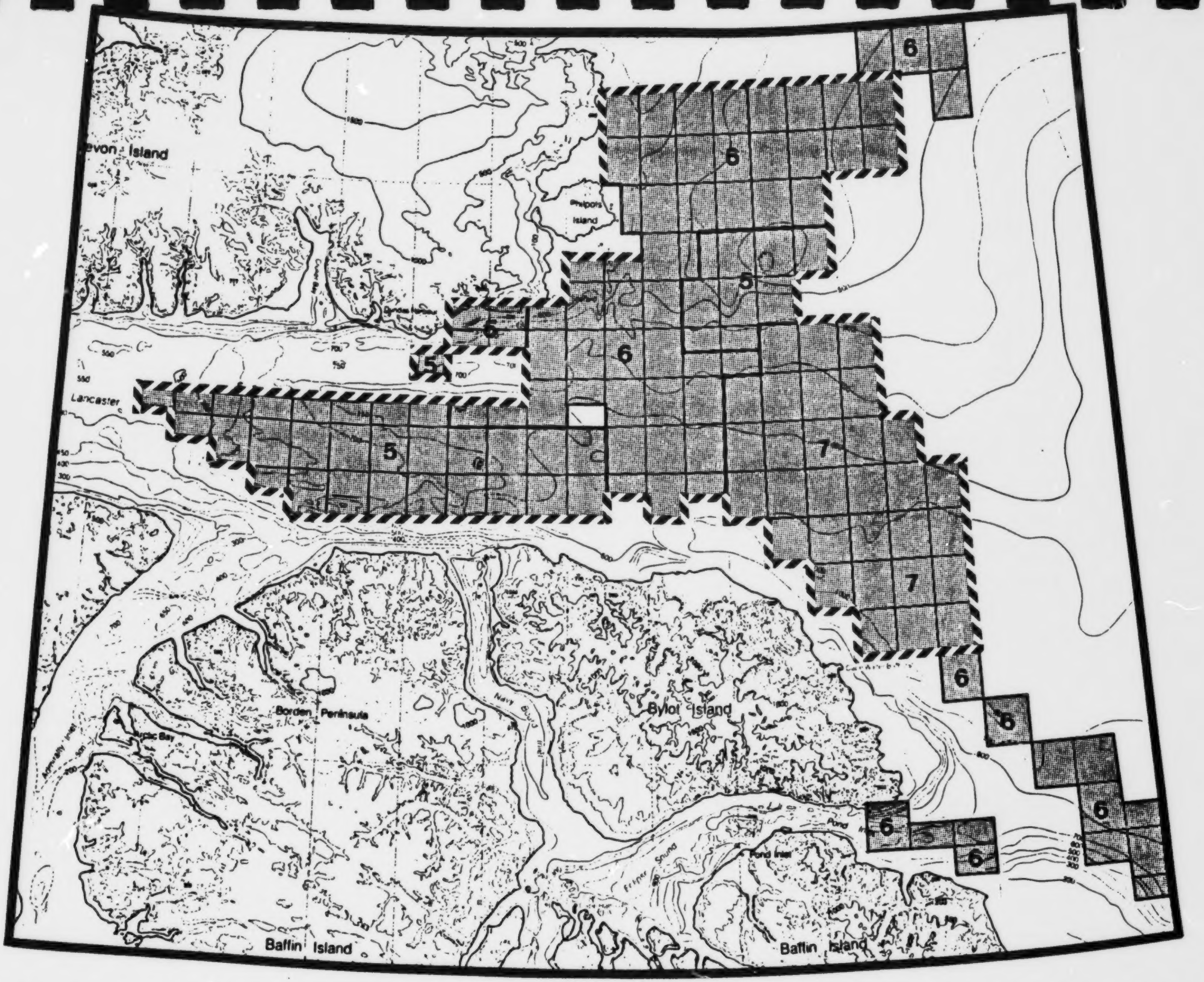

evon Island
Philpots Island
Lancaster
6
6
5
6
5
5
5
7
7
6
6
6
6
6
Bylot Island
Borden Peninsula
Navy Board Inlet
Eclipse Sound
Pond Inlet
Baffin Island
Baffin Island

**Figure 3.12** Oil and gas exploration permits within Lancaster Sound and Baffin Bay (from D.I.A.N.D., 1982), areas of active permits indicated by stripped line.

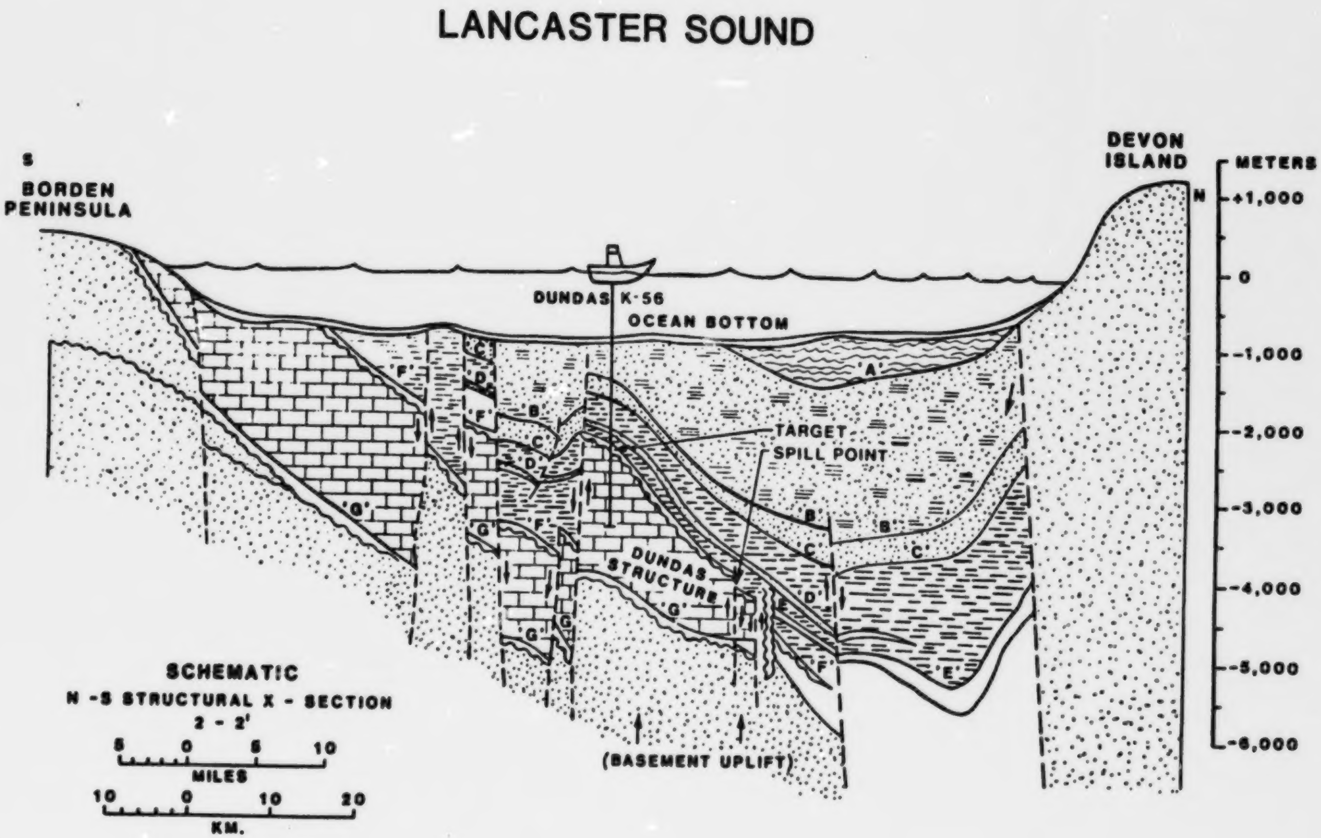

LANCASTER SOUND
S
BORDEN PENINSULA
DEVON ISLAND
N
METERS
+1,000
0
-1,000
-2,000
-3,000
-4,000
-5,000
-6,000
DUNDAS K-56
OCEAN BOTTOM
A
B
C
D
E
F
G
TARGET
SPILL POINT
DUNDAS STRUCTURE
(BASEMENT UPLIFT)
SCHEMATIC
N -S STRUCTURAL X - SECTION
2 - 2'
5 0 5 10
MILES
10 0 10 20
KM.

**Figure 3.13** Geological structure within Lancaster Sound showing the down-faulted block structure which has isolated a potential oil and gas formation called the Dundas Structure (C.M.O., 1983).

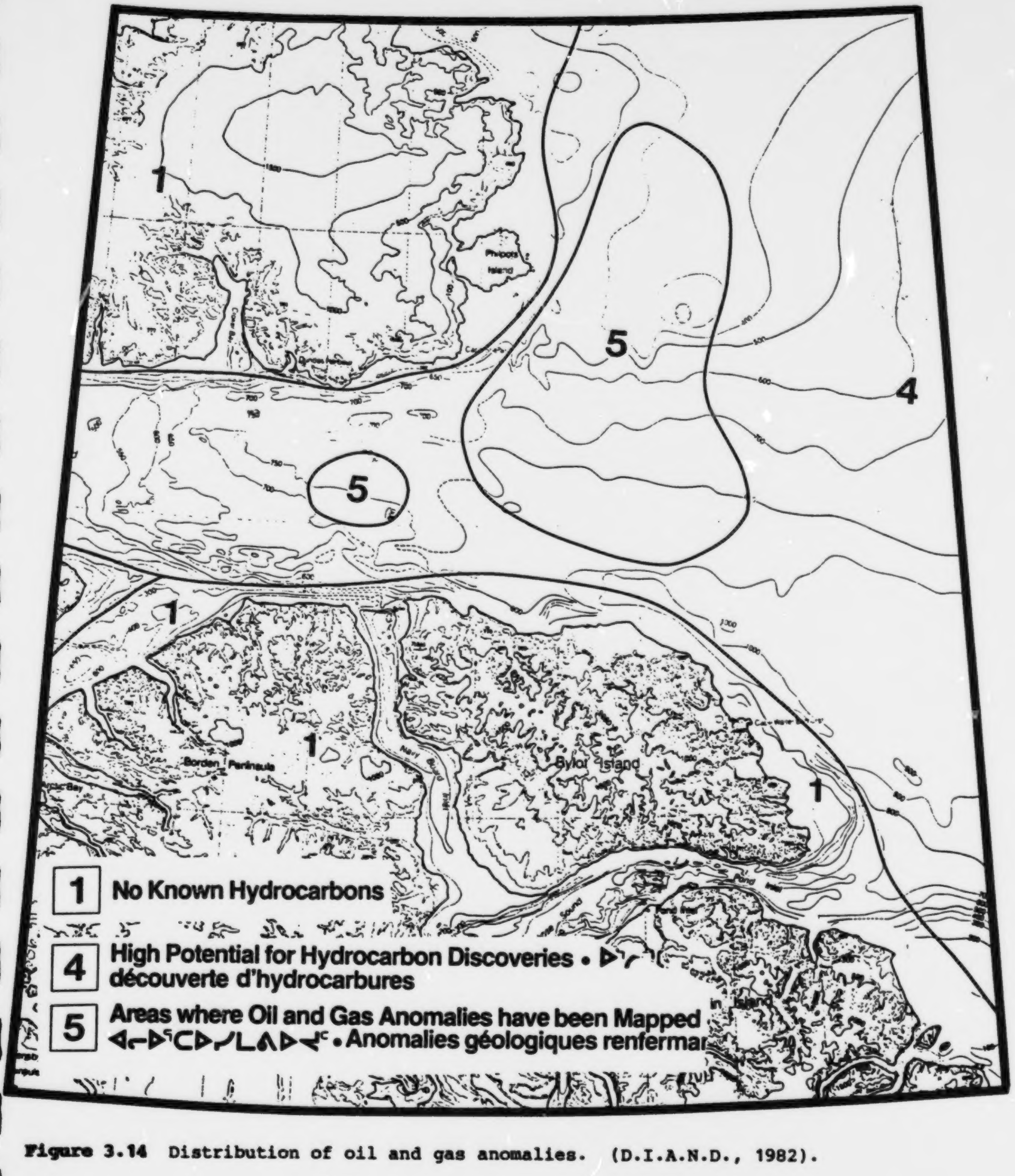

1
Philpots Island
5
4
5
1
1
Borden Peninsula
Navy Board Inlet
Bylot Island
1
Pond Inlet
1 No Known Hydrocarbons
4 High Potential for Hydrocarbon Discoveries • découverte d'hydrocarbures
5 Areas where Oil and Gas Anomalies have been Mapped • Anomalies géologiques renfermar

**Figure 3.14** Distribution of oil and gas anomalies. (D.I.A.N.D., 1982).

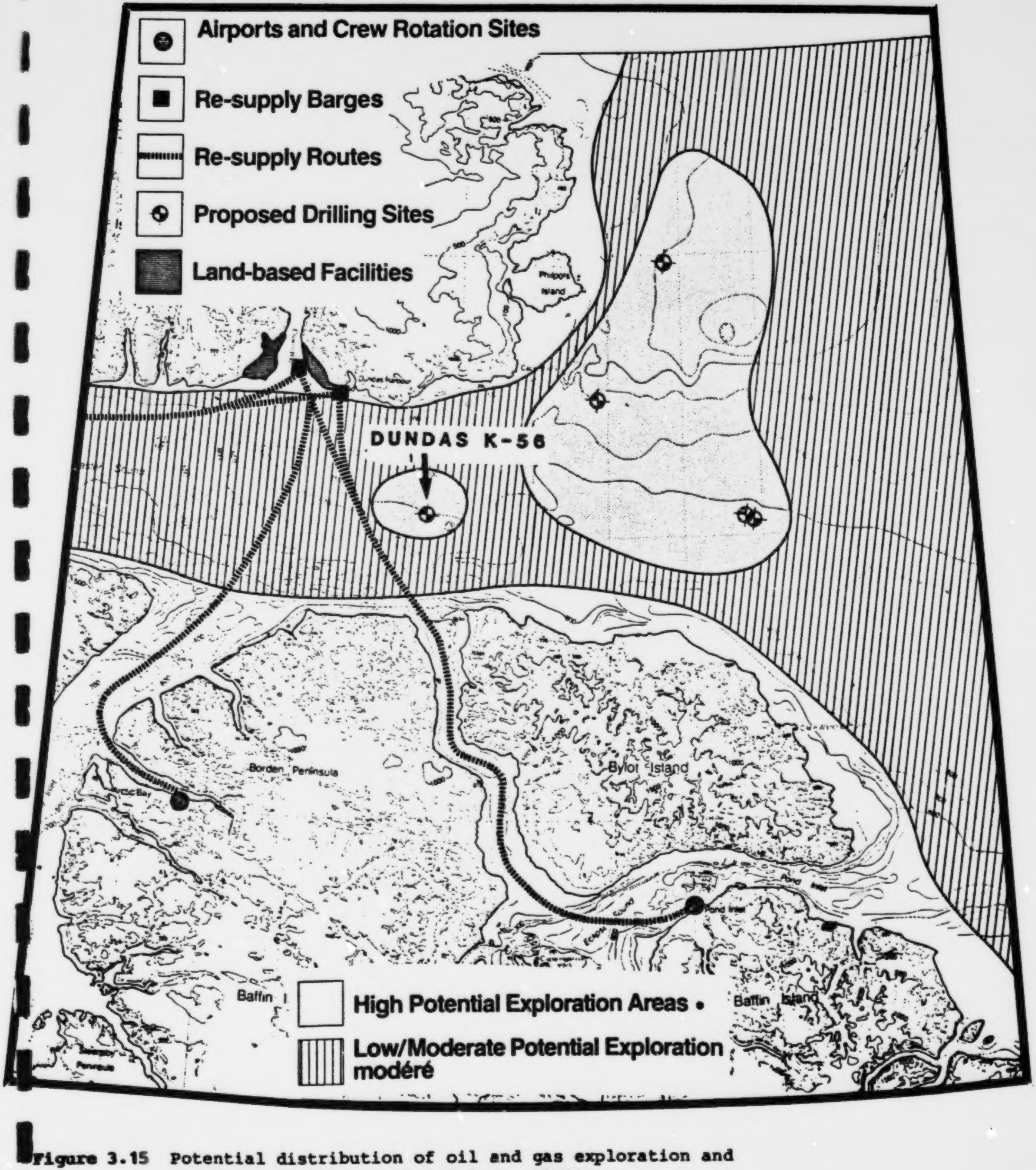

Airports and Crew Rotation Sites
Re-supply Barges
Re-supply Routes
Proposed Drilling Sites
Land-based Facilities
Philpots Island
Dundas Harbour
DUNDAS K-56
Borden Peninsula
Bylot Island
Pond Inlet
Baffin I
Baffin Island
High Potential Exploration Areas •
Low/Moderate Potential Exploration modéré

Figure 3.15 Potential distribution of oil and gas exploration and support activities. (D.I.A.N.D., 1982).

comprehensive review of all issues within the Lancaster Sound area be undertaken, and the Lancaster Sound Regional Study followed (DINA, 1982). The results of this study are assembled in a data atlas and a series of reports which describe the region's physical and biological characteristics, renewable resource use patterns, present and potential industrial and commercial activities. At the present time there is a moratorium on all exploration activity within the permit areas of Lancaster Sound and the adjacent regions of Baffin Bay, (Figure 3.12). It is also important to note that the declining world oil demand and prices have reduced the economic viability of hydrocarbon development in the study area over the short to medium term.

Future development of oil and gas reserves may be considered if the conflicts between resource development, environmental protection and native Inuit concerns are solved; and the economic conditions for arctic oil exploration improve.

If oil and gas exploration is approved by government in the future, it would initially start with a few drill ships in the area, but as activities increase there is the potential of several drillships operating during the summer months within Lancaster Sound and western Baffin Bay. These operations would require extensive support facilities and would result in greatly increased activity at surrounding communities as well as the use of local waters for resupply routes (Figure 3.15).

The construction of shorebase facilities would locally alter shorezones and perhaps impact nearshore habitats. Drilling activities, like shipping, may affect the migration patterns of marine mammals and feeding of seabirds. However, there is no evidence to suggest that whales will divert their migration patterns around man's activities. On the contrary, Mitchell and Reeves (1982) state "There is no reason to believe that bowheads will be able to change their distribution, movements or behavior to accommodate the plans of oil and gas companies. While being hunted to near extinction in the past, they apparently made no such adjustments to avoid their pursuers".

If discoveries of oil or gas are made, and if production is economically viable, then exploration, production and support activities would increase in the Lancaster Sound area. Sea floor structures would be built, and tanker terminals and support facilities along the coast would be enlarged (Figure 3.16). With this increase in tanker traffic and the use of sea floor production platforms the probability of a marine oil spill would also increase.

The impact of a marine oil spill is difficult to delineate beforehand. The location and size of the spill, ice, wind and tide conditions would all play a part in the areal extent of the spill. Studies have been made of physical parameters in Lancaster Sound in the areas of potential oil production and results show that the entire study area is susceptible to pollution from an oil spill (Figure 3.17). It must be emphasized that the extent of contamination depicted in Figure 3.17 is the worst possible case, and the risk of this degree of pollution is low (i.e. the risk of uniform pollution of a very wide area). Nonetheless, potential impact upon any smaller, nearby area will remain highly negative, depending on ice and climate conditions at the time.

Since 1978, staff of the Arctic Marine Oilspill Program (AMOP) of which Environment Canada is the lead agency, has undertaken to identify and co-ordinate research needs associated with experimental oil spills in cold Canadian Waters (AMOP, 1979). In 1980 AMOP initiated a project, along with industry (e.g. Petro-Canada) and private consulting companies, to study the effects of spilled oil at a shoreline site located at Cape Hatt within Eclipse Sound (Figure 3.18). Known as the Baffin Island Oil Spill (BIOS) project, this study has involved a multidisciplinary group of scientists. The main emphasis of the project has been to study the effects over several years of a model oil spill on the arctic marine environment. To this end, controlled oiling of several beaches and bays took place in the Cape Hatt region in 1980, 1981 and 1982. The project was completed in 1985 and the sites have received a special scientific reserve status. Preliminary results suggest that the use of dispersants causes less impact over the medium term than does not using dispersants; oil stranded on the

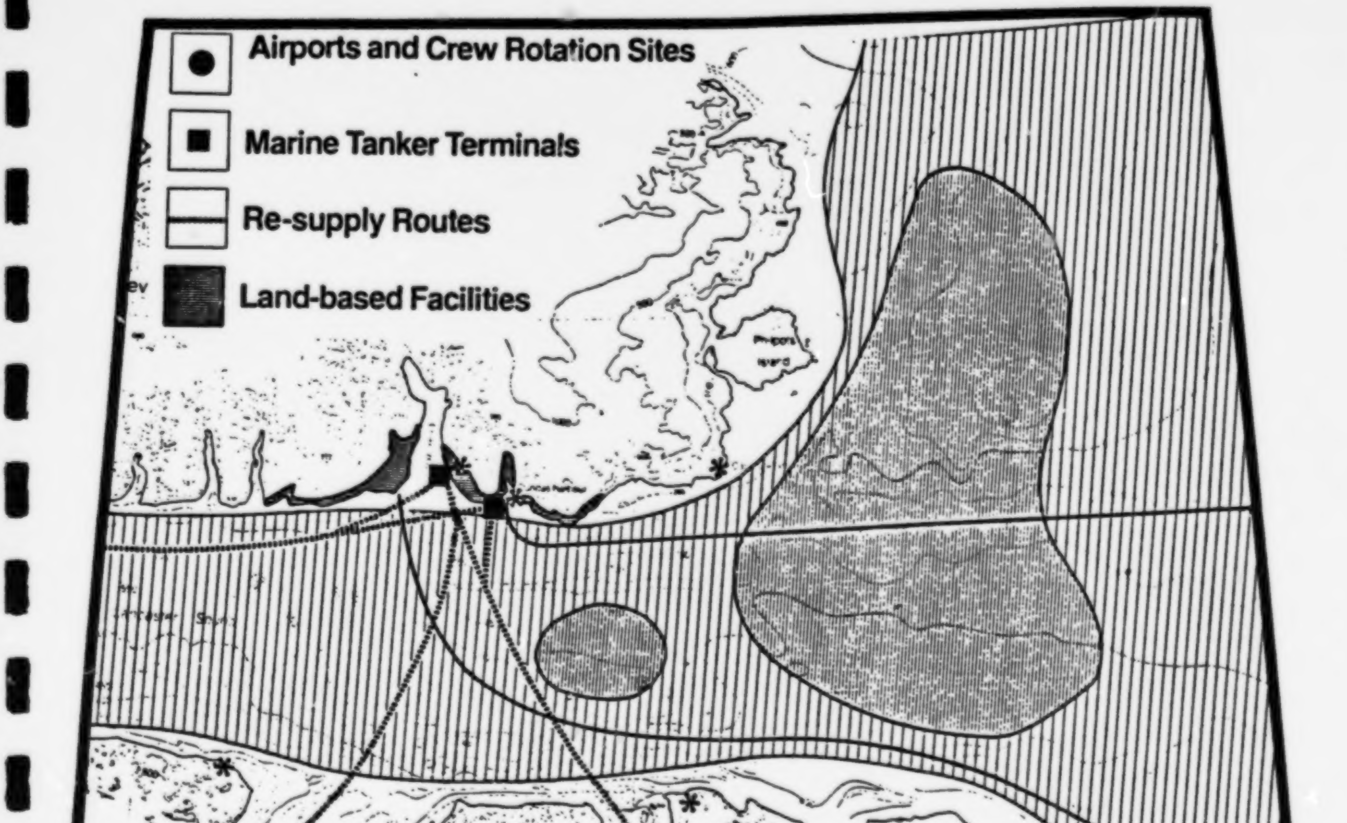

Airports and Crew Rotation Sites
Marine Tanker Terminals
Re-supply Routes
Land-based Facilities
High Potential Development Areas
Low/Moderate Potential Development Areas
Shipping Corridor
Staging Airstrips
Borden Peninsula
Bylot Island
Baffin Island
Baffin Island

Figure 3.16 Potential production activities from oil and gas discoveries (D.I.A.N.D., 1982).

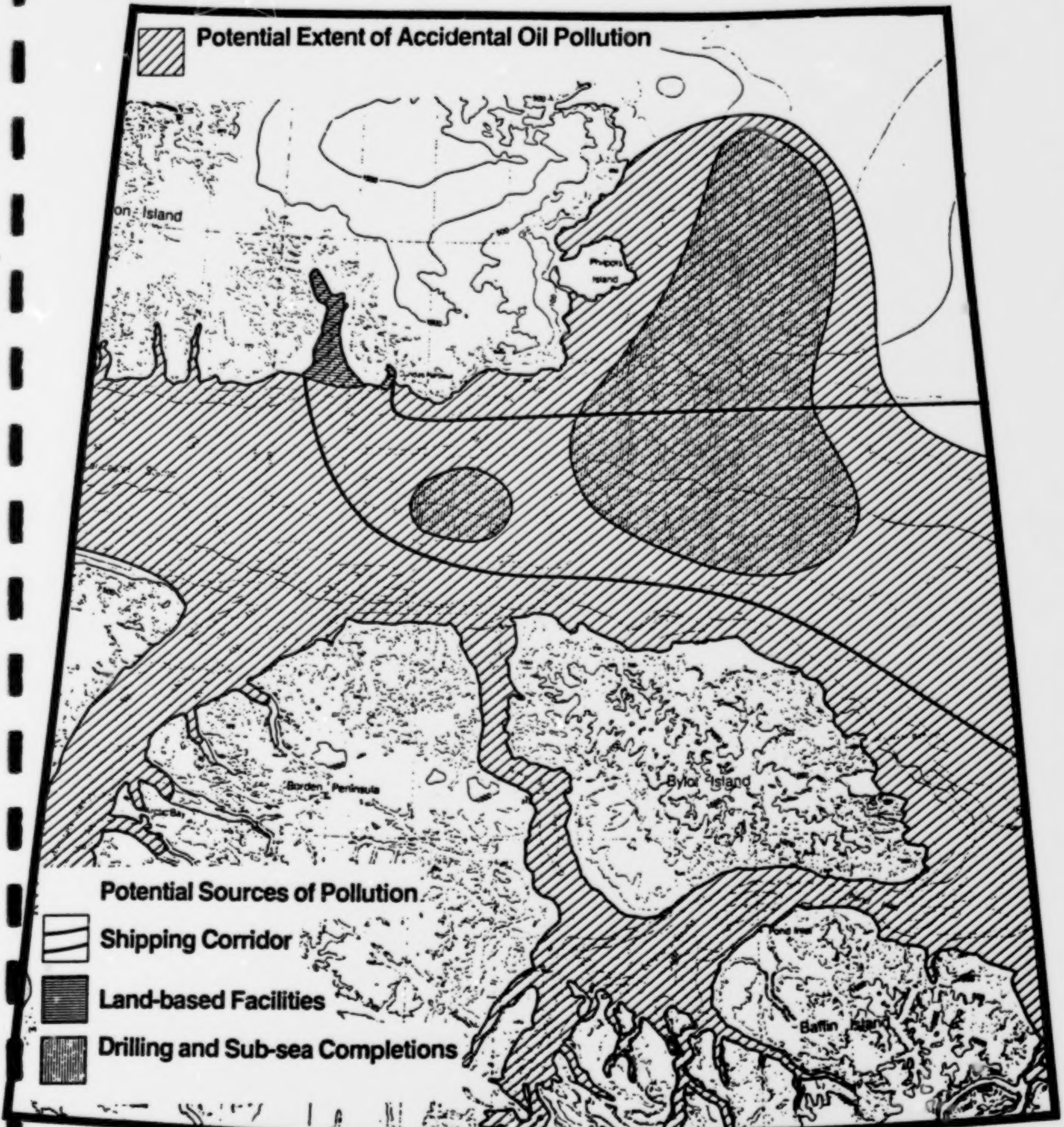

Potential Extent of Accidental Oil Pollution
on Island
Philpots Island
Bylot Island
Borden Peninsula
Baffin Island
Potential Sources of Pollution
Shipping Corridor
Land-based Facilities
Drilling and Sub-sea Completions

Figure 3.17 Maximum potential pollution from an oil spill (D.I.A.N.D., 1982).

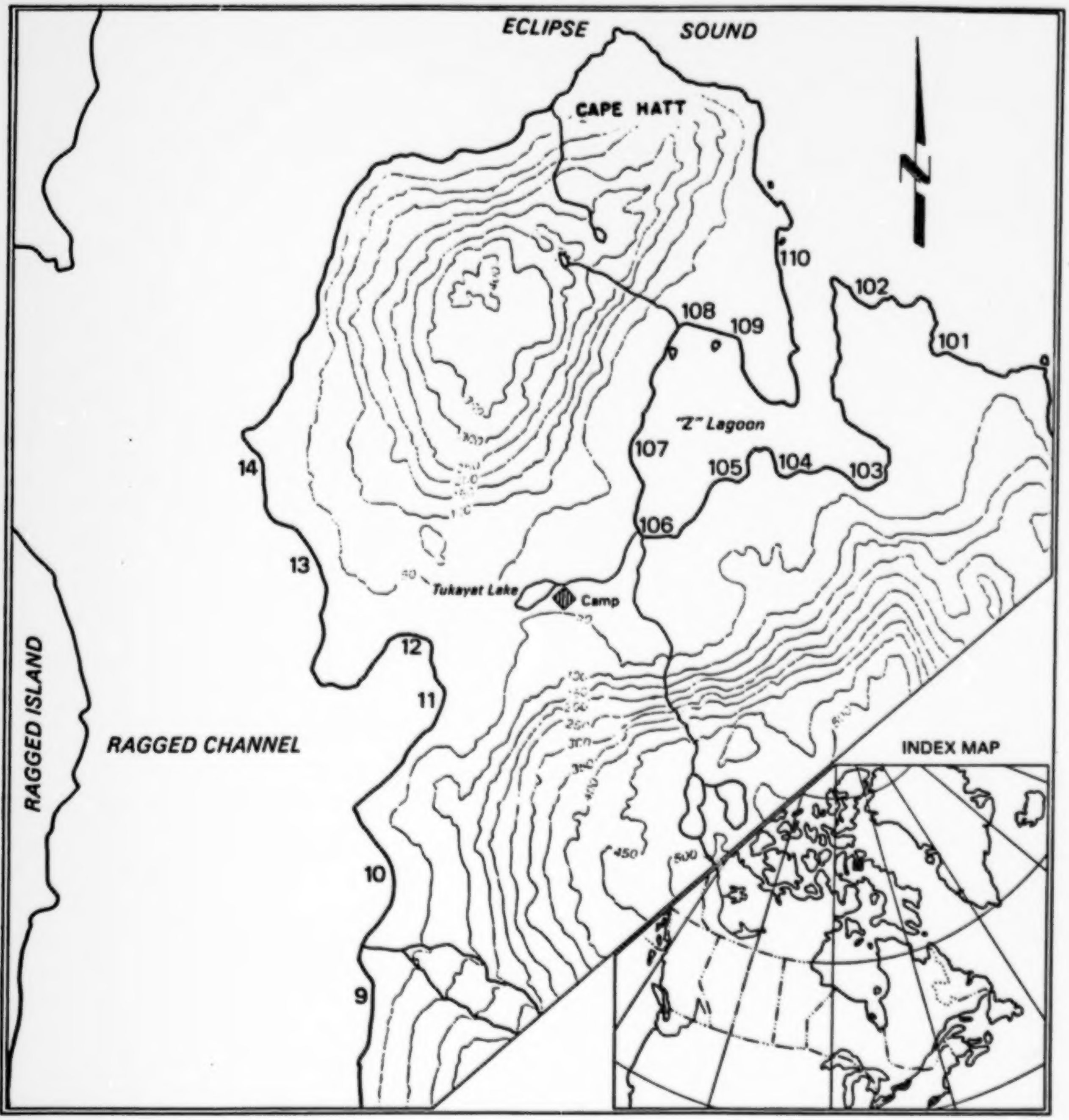

ECLIPSE
SOUND
CAPE HATT
N
110
102
101
108
109
"Z" Lagoon
107
105
104
103
14
106
13
Tukayat Lake
Camp
12
11
RAGGED ISLAND
RAGGED CHANNEL
INDEX MAP
10
9
450
500
Approximate scale
0
500
1000 m
Contour Interval = 50 m

**Figure 3.18** Location of the Baffin Island Oil Spill (B.I.O.S.) project. The numbers indicate bays for potential experiments.

shores where dispersant was not used is gradually migrating into the shallow nearshore sediments and being incorporated into benthic organisms.

The effects an oil spill would have on the biological community would again depend on the nature and extent of the spill. The effects of oil spills on seabirds have been documented from other spills around the world (e.g. the recent spill from the Arco Anchorage in the Strait of Juan de Fuca, B.C. in December, 1985) and similar situations would result in Lancaster Sound. These would include, for example, poisoning from oil ingestion and coating by oil preventing flight and reducing insulating properties of their feathers. The effects on marine mammals, while not clearly understood, might include ingestion of oil, inbalance of body temperature from oil coating, disruption of normal reproductive activities, and temporary or permanent eye damage. Of particular concern would be the bowhead whale, not only because of its endangered status, but because it is a baleen whale and could inadvertently ingest oil while feeding.

The effects of oil within the ice environment will depend on the time of year of the spill or subsea blowout. In the summer months ice will have little effect in the eastern Lancaster Sound region however if a major spill occurred to the west along the ice area much of the oil could be concentrated in the locally productive biological region. In the winter periods, oil spills in and under the ice would concentrate within open water leads and along ship tracks. The freezing conditions of the colder months would trap oil within new ice formations. Oil thus trapped could be released the following spring or possibly held for several years within multi-year ice.

In the event of oil reaching the shore zone, contamination of beaches, lagoons, estuaries and rocky coast habitats would result. The physical sensitivity of the coastal regions of the Lancaster Sound/Eclipse Sound region to an oil spill has been classified according to morphology and substrate and is given in Figure 3.19. This sensitivity rating is a relative measure (low to high) of the seriousness of oil pollution in a

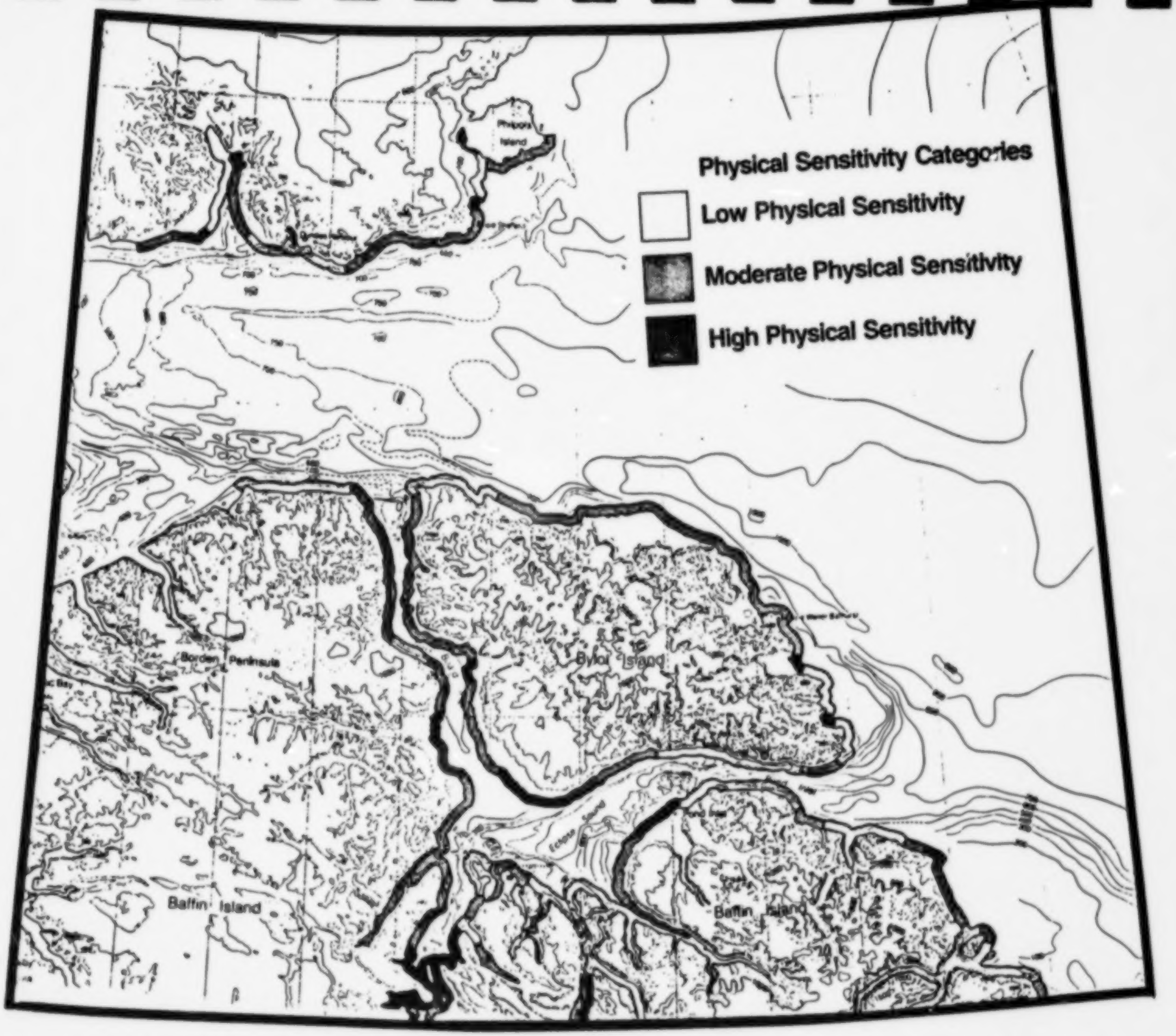

Physical Sensitivity Categories
Low Physical Sensitivity
Moderate Physical Sensitivity
High Physical Sensitivity
Philpots Island
Borden Peninsula
Bylot Island
Eclipse Sound
Baffin Island
Baffin Island

Figure 3.19 Coastal sensitivity to an oil spill based on morphology and substrate (D.I.A.N.D., 1982).

particular environment with respect to probable dispersal of oil, residence time and clean-up difficulties.

### 3.2.3 Mining

Although there are no mines within the study area, a major lead-zinc mine (Nanisivik Mines) is located on Strathcona Sound on the western shores of the Borden Peninsula. The geological structures which contain the lead-zinc mine at Nanisivik continue across the Borden Peninsula, and several mining prospecting permits are held within the region (Figure 3.20). Potential additional ore discoveries will lead to increased exploration. Favourable geology for additional lead-zinc deposits is found along Navy Board Inlet and Milne Inlet (Figure 3.21). An assessment of the mineral potential of the study area which is being carried out by the Geological Survey of Canda should be completed by the summer of 1986.

There is a large high-grade iron property at Mary River, 88 kilometers southeast of the head of Milne Inlet. There are no plans at present to develop this property; however, under the right economic conditions extraction of the ore could become commercially viable. A construction road was built from Milne Inlet to the mine site in 1965 and there were plans for an air strip to be built. Large quantities of deteriorating construction supplies remain stockpiled at the Milne Inlet terminus of this road.

Shipments of ore would likely be by truck to a stock piling facility and port for supply ships and ore carriers at Milne Inlet, then by ship through Eclipse Sound and Pond Inlet. Shipping operations to and from such a port would traverse Koluktoo Bay which is a major char fishing area. Possible detrimental effects of the port operation to the fish and narwhal populations would require additional study.

There are coal bearing rocks along the southwest corner of Bylot Island and along the southeast shore of Eclipse Sound near the community of Pond Inlet

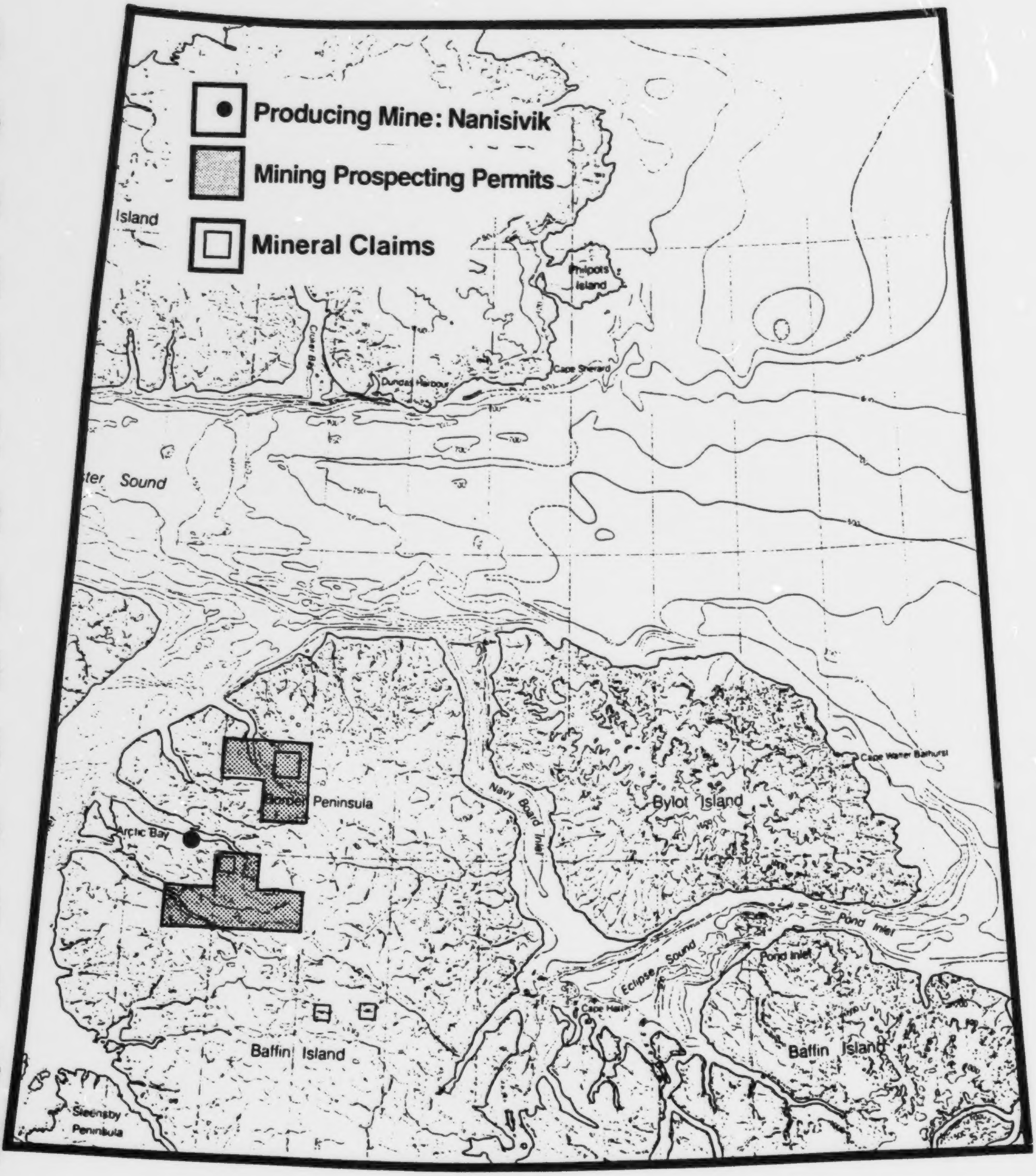

● Producing Mine: Nanisivik
▨ Mining Prospecting Permits
☐ Mineral Claims
Island
Philpots Island
Croker Bay
Dundas Harbour
Cape Sherard
ter Sound
Borden Peninsula
Arctic Bay
Navy Board Inlet
Bylot Island
Cape Walter Bathurst
Pond Inlet
Eclipse Sound
Pond Inlet
Cape Hatt
Baffin Island
Baffin Island
Steensby Peninsula

Figure 3.20 Prospecting permits within the study region (Source: D.I.A.N.D., 1985).

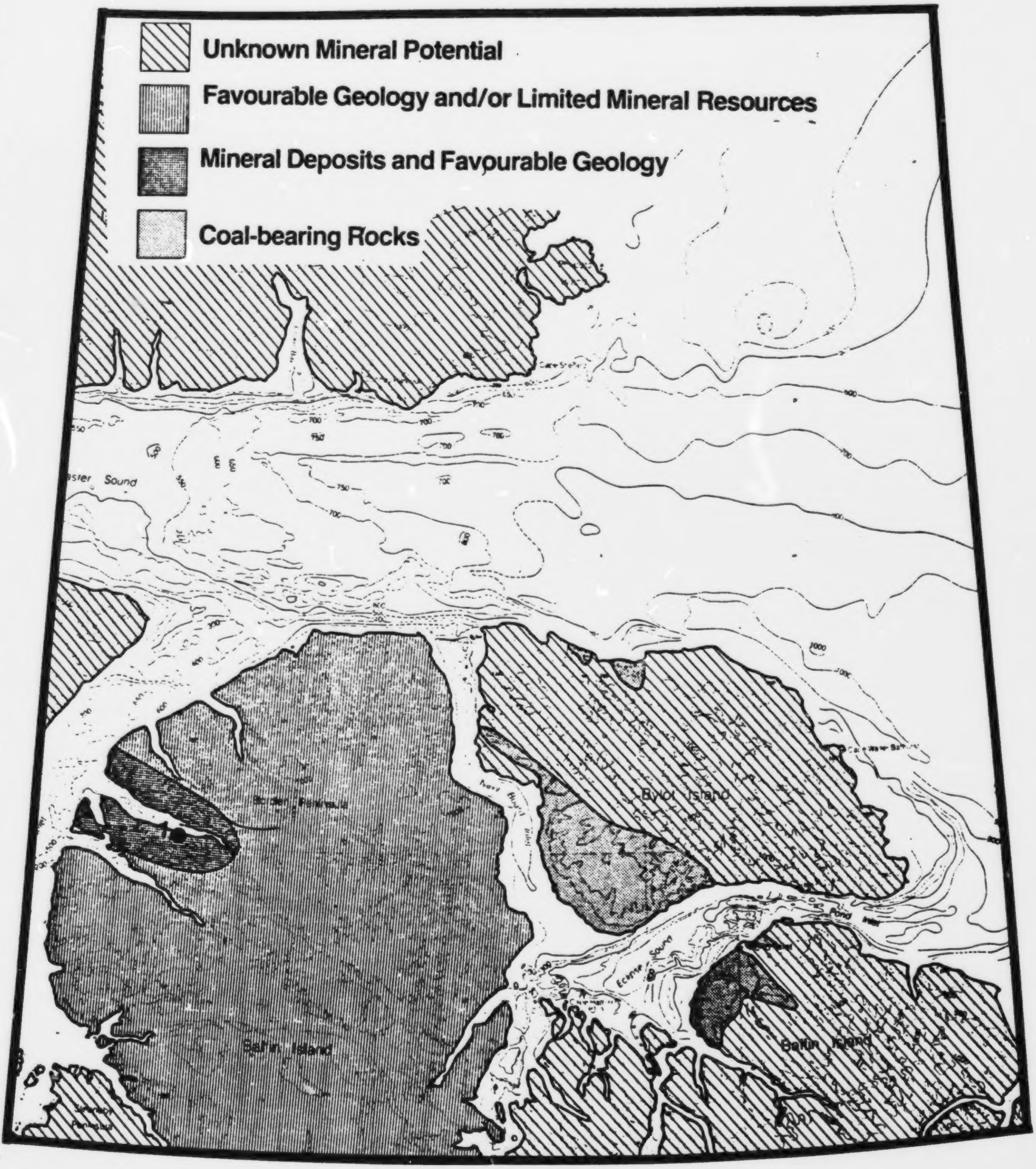

Unknown Mineral Potential
Favourable Geology and/or Limited Mineral Resources
Mineral Deposits and Favourable Geology
Coal-bearing Rocks
aster Sound
Borden Peninsula
Navy Board Inlet
Bylot Island
Pond Inlet
Eclipse Sound
Baffin Island
Baffin Island

Figure 3.21 Distribution of mineral potential (D.I.A.N.D., 1982).

(Figure 3.21). There was an active coal mine at Salmon River (see Figure 2.84 and Table 2.12) in the early 20th century (1912 - 1914). Inuit from Pond Inlet continued to remove coal from this site until 1964. The present low world price for coal and the remote geographical location of the site does not support a viable commercial operation.

Sand and gravel beaches and barriers are common along much of the shoreline of the study area and could provide sources of aggregate material for construction and oil and gas production facilities (Figure 3.22). Energy Mines and Resources feel there is some potential for working beach placer deposits. The impact of aggregate mining of beach deposits and placer operations could be detrimental to coastal habitats (e.g. nesting colonies, polar bear dens, fish spawning). Sand and gravel removal from barrier beaches could alter the stability of coastal sediment regimes and increase the exposure of backshore lagoons and estuaries to prevailing storms.

### 3.2.4 Settlements

The major community within the Lancaster Sound/Eclipse Sound region is Pond Inlet (see Section 3.1). At the present time this community is populated by Inuit whose major occupation is hunting and fishing. Waste discharge at the community of Pond Inlet is restricted to normal human activities, there are at present no industrial facilities discharging waste into the environment, and the impacts from this discharge are minor and local.

Port facilities at Pond Inlet are virtually non-existent and supplies are off-loaded from ships onto the beach. The impacts from these operations are minimal and restricted to normal ship operations (e.g., minor waste discharge). There is, however, always the potential for fuel oil spills even from small freighters. Future expansion of port facilities will depend on the nature and degree of development in the eastern arctic. For example, if oil and gas exploration proceed in the region, Pond Inlet could become a major transhipment point for air cargo and ships bringing in materials and personnel for drilling operations.

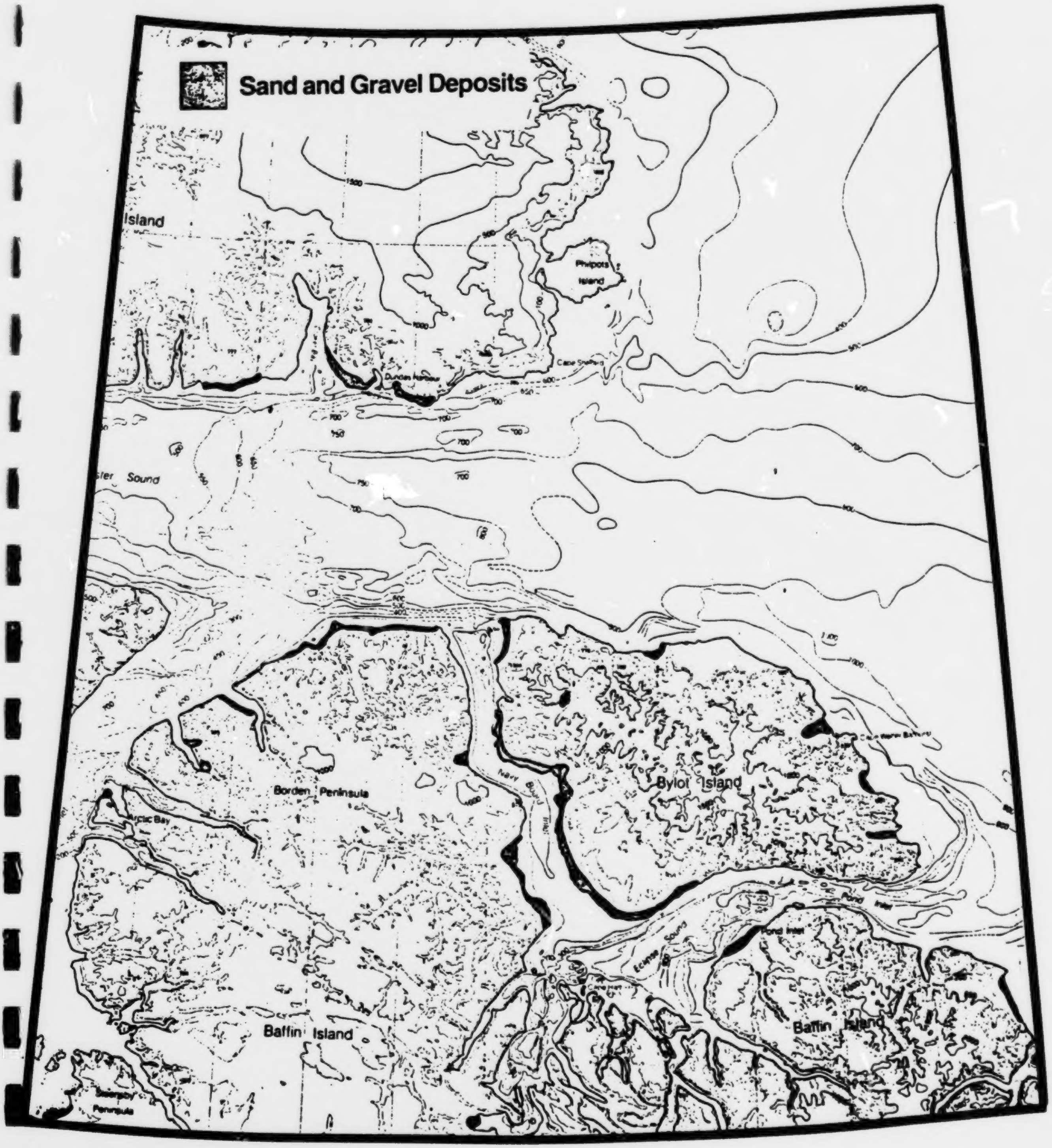

Sand and Gravel Deposits
Island
Philpots Island
Cape Sherard
Dundas Harbour
ster Sound
Borden Peninsula
Arctic Bay
Navy Board Inlet
Bylot Island
Eclipse Sound
Pond Inlet
Baffin Island
Baffin Island
Steensby Peninsula

Figure 3.22 Potential commercial sand and gravel deposits (D.I.A.N.D., 1982).

### 3.2.5 Recreational Activities/Tourism.

At present, tourist recreational activities in the study area are predominantly restricted to hiking, sight-seeing and guided sport-fishing. The community of Pond Inlet is the base for much of this activity. Guided sport-fishing and small boat adventures are carried out in the sheltered waters of Eclipse Sound and its fjords. A recreational sport fishing camp is maintained in the summer months at Koluktoo Bay at the head of Milne Inlet. The impact from these activities is, at present, minimal, but future development of tourism in the area could pose potential problems. Increased use of coastal areas by hikers (skiers in the winter) could disturb wildlife habitats (e.g., waterfowl nesting sites). Recreational fishing activities could deplete stocks of char, which would be a threat to the local Inuit subsistence lifestyle. A complete discussion of tourism is presented in Section 4.0.

### 3.2.6 Other Non-Inuit Impacts

Over the last decade many non-Inuit activities (e.g., scientific research, resource exploration and fishing) have utilized varying modes of transportation throughout the study region. One of the major modes of transport has been by aircraft. This has resulted in the widespread distribution of discarded 45-gal. fuel drums along coastlines (e.g., the southern and western coasts of Eclipse Sound and its fjords). The impact of these fuel drums on the naturalness of the region is minimal, and is predominantly a matter of aesthetics. Clean-up and removal of fuel drums from coastal environments would be easy if required and could be carried out from Pond Inlet.

At this time there are no known military areas (e.g., Department of National Defence exercise areas) or ocean dumping permits in the Lancaster Sound/ Eclipse Sound region. Future considerations for these uses may be made as political and national defence policies change (i.e., cruise missile tests are currently being carried out over the Beaufort Sea).

# 4.0 ASSESSMENT OF VISITOR USE POTENTIAL

An assessment of visitor use potential in an Eclipse Sound/Lancaster Sound marine park requires an understanding of the types of activities which may be of interest to visitors to the region and an evaluation of the facilities which are required for these activities.

The type and extent of facilties which are presently available or which will be added with the development of a park will help determine potential visitor use. An increasing number of people in our urban society are interested in a "wilderness experience", but relatively few people are experienced enough to safely venture alone into this environment. The majority of potential visitors to the area will need some degree of support. This could consist, at a minimum, of guidance through printed information or verbal instruction at park facilities, but more realistically would involve guides and/or support personnel. As park facilities and infrastructure increase, self-guided activities could also increase: however, for more remote areas guided activities will be required for most visitors.

Three criteria for evaluating visitor use within a marine park have been presented in a previous Parks Canada study (James Dobbin Assoc. Ltd, 1981b). These are the principles of understanding, appreciation and enjoyment, and they are summarized below in terms of their context within the study area.

Promoting an understanding of the marine environment implies increasing visitors' familiarity with the park setting through information, presentation and exploration of physical, biological and cultural features, for example:

- the variety, quality and representativeness of coastal and marine geological and oceanographic processes and features encountered during the visit (e.g., sandy beaches, fjords, barrier islands, rock cliffs, tidewater glaciers);

- the variety, quality and representativeness of flora and fauna in and associated with the marine environment (e.g., whales, polar bears, seabirds, seals, walruses);

- the variety, significance and representativeness of historical, cultural and socio-economic features encountered during the visit (e.g., Northwest Passage explorers, whaling stations, fishing settlements, trading posts, archaeological sites);

- the familiarity with the marine environment gained through participation in visitor activities.

Providing an appreciation of the marine environment implies an increase in the value the user places on maintaining its naturalness and protecting its resources, for example;

- the nature of the contact with the marine habitat type or resource, yielding a sense of wonder, discovery, pride and inspiration;

- whether the overall experience provides the user with an appreciation of the uniqueness or significance of the marine park visited;

- whether the overall experience stirs the imagination of the visitor by suggesting past events and future opportunities related to the marine environment.

Promoting enjoyment of the marine environment implies the user receiving a feeling of challenge, anticipation and/or relaxation from the activity or sport carried out while in the park. Criteria used for evaluating enjoyment could, for example, include:

- the popularity of the use (i.e., whether it can be enjoyed by a variety of park users with different expectations, ages and skills);

- the self-reliance of the use (i.e., whether it needs assistance, supervision or major facilities);

- the seasonality of the use and whether the use provides a variety of experience during different seasons;

- the safety of the use and whether the user can enjoy the experience free from anxiety.

## 4.1 PRESENT VISITOR USE

There has been a marked increase in recreational visitor activity in the Bylot Island/Eclipse Sound area in recent years, as a result of improved air transportation and the development of a hotel at Pond Inlet. An estimate of the number of visitors to the area is, however, still less than 500 annually, with a strong international contingent (James Dobbin Assoc. Ltd., 1981b). Several of these persons though classified as visitors have been involved in scientific and resource activities in the area (e.g. the B.I.O.S. project). Within a wilderness environment such as the Bylot Island/Eclipse Sound area, the distinction between visitor and scientist is often marginal, as one of the principal criteria for park development is to provide the opportunity for increased user awareness and understanding of the environment.

The main non-scientific visitor activities have been restricted to local sightseeing and nature viewing around the community of Pond Inlet and southeastern Bylot Island, sport fishing at the mouth of the Robertson River in Koluktoo Bay in southern Milne Inlet and minimal boating within the sheltered waters of Eclipse Sound and Navy Board Inlet (Figure 4.1). These activities have been concentrated in the three summer months of July to September.

In 1984 the first cruise ship (the Lindblad Explorer) visited the area. A second cruise ship visit was made in the summer of 1985 and a third is planned for the summer of 1986. In addition, a sailing yacht made a visit to Lancaster and Eclipse sounds in the summer of 1985.

The present infrastructure to support visitor use in the study area is mainly at Pond Inlet. There is minimal tourist activity at Resolute, which is a transfer point for flights to Ellesmere Island, and none at Arctic Bay and Nanisivik. The Toonoonik-Sahounik Co-op operates a year-round hotel in Pond Inlet and a summer sports fishing camp at Koluktoo Bay at the head of Milne Inlet. Guided boat charters are available and charter aircraft services can be arranged. Pond Inlet also has a Hudson Bay Company store and other facilities where supplies and materials for wilderness trips can be purchased.

Guided "Journeys of Canadian Discovery" are offered by a Vancouver-based company, EcoSummer Canada Expeditions, within the area. For the past four years they have run ocean kayaking trips in the sheltered waters of Eclipse Sound. Flown by Twin Otter to the head of Milne Inlet, the tour travels 100 miles northeast along the shoreline, ending in Pond Inlet. The firm's brochure states "Kayaking requires previous experience and may involve hard going in adverse environmental conditions".

Special interest users such as sports fishermen, wilderness adventure groups, and scientific researchers are going to continue to be the main visitors in the area until facilities increase. The hotel at Pond Inlet is

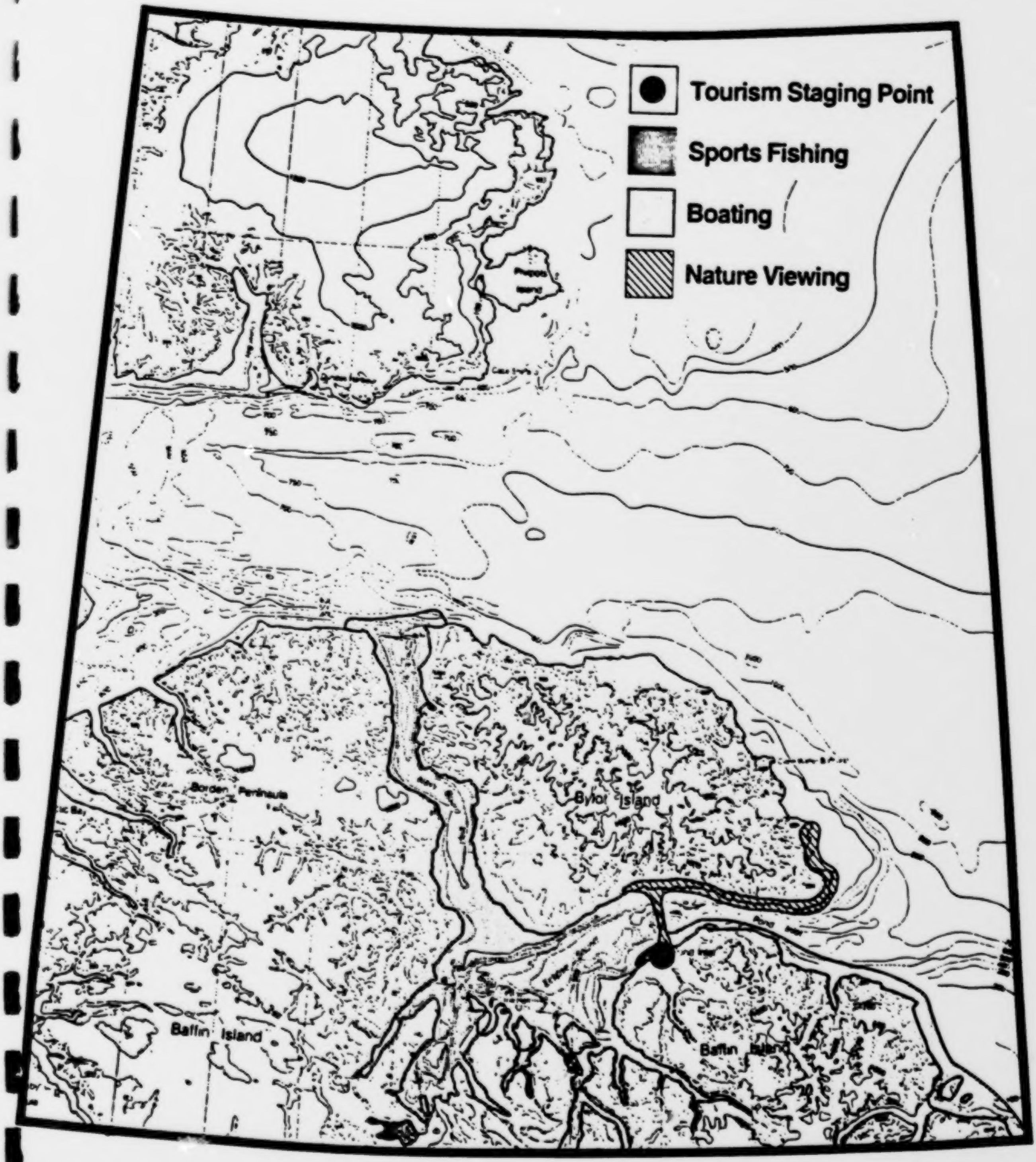

Tourism Staging Point
Sports Fishing
Boating
Nature Viewing
Borden Peninsula
Bylot Island
Baffin Island
Baffin Island

Figure 4.1 Current tourist activities in the Eclipse Sound/Bylot Island area, (D.I.A.N.D., 1982).

already at capacity during the summer months and a new, larger Co-op hotel is being constructed at present. The potential for increased use and other new or expanded facilities is good.

Tourism-related activities would be expected to expand with the development of a park, creating employment and business opportunities for local Inuit. Such activities could include managing tours, outfitting, guiding, providing transportation and accommodation, and selling arts and crafts. Regardless of the season, the production and sale of skin and fur handicrafts, bone and stone carvings or local souveniers could offer steady employment and a source of cash income for native artists, distributors and store owners. Arctic tourism is relatively compatible with community life and preferred Inuit lifestyles. In addition, it is an industry that the Inuit could largely control and one that probably has a longer life span than any of the currently envisaged non-renewable resource extraction projects (DINA, 1982).

## 4.2 POTENTIAL VISITOR USE

In order to evaluate the potential use of the area it is necessary to define the market or audience. Visitors to the park will have diverse backgrounds, interests and needs and, as such, will be in search of a variety of different activities. In general visitors are most likely to be wilderness oriented, and expensive transportation costs to the site are likely to result in mostly educated, middle- to upper-income visitors. It is then necessary to define the facilities which will be required to accommodate these activities.

### 4.2.1 Activities

The activities available to visitors of the Bylot Island/Eclipse Sound/ Lancaster Sound area are going to be predominantly wilderness activities. Leisure activities such as swimming and waterskiing may be compatible with a marine park but are unrealistic in the arctic environment. A compilation of activities compatible with the environment is provided in Table 4.1. Many of these activities overlap, but for discussion purposes they are described individually.

**Table 4.1 Visitor Use Activities.**

Boating
Sport fishing
Scuba Diving
Shore activities
Seascape viewing
Wildlife watching
Historical and archaeological appreciation

### (a) Boating

Boating is one of the principal activities associated with any marine park. It provides a means of transportation within the park and a vantage point from which the resources of the marine environment can be viewed. It is easily accessible to most visitors to the park as it requires minimal skills.

Travelling along the coastline, boats would allow an excellent view of coastal features (e.g. coastal cliffs, tidewater glaciers, barrier islands). Boats would also provide an excellent vantage point from which to view marine wildlife (e.g. whales, seals, polar bears and sea bird colonies on coastal bluffs). A feeling for the marine environment is provided by being on the water. The boater could experience arctic marine conditions (e.g. ice bergs, ice flows) and visit cultural and historical sites along park coasts.

Educational and interpretative programs can easily be integrated with boating in the form of guided tours or information (e.g. pamphlets on safe boating in Arctic waters; descriptions of wildlife in the area; maps showing the locations of sites of interest) provided at a park orientation centre in Pond Inlet. Such programs could make boaters aware of fragile coastal and marine habitats, historical and archeological sites as well as the dangers of the marine environment (e.g. ice bergs, polar bears). The local Inuit people live closely with the sea and would be ideally suited to aid in these programs and provide boat tours.

(b) Sport Fishing

Sport fishing is permitted under Parks Canada policy. There are excellent sport fishing opportunities within the study area, predominantly for Arctic char. Many of the rivers in Eclipse Sound, Navy Board Inlet and the bays and inlets to the south support populations of anadromous Arctic char. During the summer, char migrate to the sea to feed and are common in the waters of Koluktoo Bay, Milne Inlet, Tay Sound, Paquet Bay, Oliver Sound, Guys Bight and Erik Harbour within the study area. Perhaps the most important of these, in terms of recreational use, is the Robertson River - Koluktoo Bay population. A summer fishing camp operated by the Toonoonik - Sahounik Co-op at Pond Inlet already provides fishing charters in this area. Fishing for both anadromous and non-anadromous char would be possible through the ice in the spring if the facilities were present to support this activity. There would be a need to instigate a monitoring program to evaluate sustainable yield as the fishery plays an important part in the subsistence lifestyle of the local Inuit people.

(c) Scuba Diving

An interest in the underwater environment is increasing rapidly, as evidenced by the growing public concern for the sea. Scuba diving offers a unique way of viewing this environment and as a sport is growing rapidly in Canada as well as the rest of the world.

"Scuba diving stands out as one of the most effective ways of experiencing the marine environment. It provides access and direct contact with a variety of subtidal habitats and physical features such as underwater shelves, reefs, subsurface cliffs and caves, boulder fields and drowned river channels. It serves in understanding biological features such as kelp beds, bottom and surface fish communities, and animal behaviour such as territoriality and migration. Unusual cultural features such as historical wrecks can be discovered and explored. More than any other activity however, scuba diving brings an appreciation for the three-dimensional quality of the marine environment. Finally, it is a sport that offers challenge and satisfaction and provides an opportunity to develop specialized skills" (James Dobbin, 1981b).

This potential use of the study area would be an ideal means by which to explore and appreciate the local marine environment. The inland waters of Eclipse Sound would provide sheltered areas for diving. The old whaling and Inuit camp sites along the coast could provide excellent opportunities for discoveries and interpretation. The ice environment could provide a unique opportunity for adventure to the experienced ice diver.

Although scuba diving would be highly compatible with the objectives of a marine park, it is a sport available only to the trained individual. Particular concern would have to be placed on the safety aspect of diving within the arctic environment of the park. In addition, the sport would require support facilities (e.g. air stations) in order to be an effective activity. These facilities could be provided at Pond Inlet if there were sufficient demand.

### (d) Shore Activities

The arctic environment would limit the amount of shore-zone water activities, with the exception of scuba diving. Shore activities would be mainly limited to coastal hiking within the summer and skiing or sledding in the winter. Beach areas would also provide camping sites for wilderness adventure trips, fishing charters or any other extended activity in the park. These activities would provide an excellent way to view coastal environments, processes and wildlife. Because much of the coastal area within the proposed park is steep and rocky, access to the beaches will be mainly from the sea. However, if a terrestrial park is established in conjunction with the marine park, backshore trails may provide increased access to more coastal areas.

During the winter months the waters of Eclipse Sound are frozen and shore access by skis, snowmobile or dogsled would be necessary. The climate at this time of the year would make use of the area attractive to only the hardiest of adventurers.

### (e) Seascape Viewing

Most visitors to marine parks come to see beautiful seascapes. The scenic beauty of an area is made up of many factors which together provide a visual effect pleasing to the individual. Within the study area many spectacular features (e.g. coastal cliffs, tidewater glaciers, barrier beaches, ice bergs) provide the visitor with a unique opportunity to experience the beauty of the arctic environment of eastern Canada. These opportunities may be of particular interest to both professional or amateur photographers and artists. Observations of both the marine and coastal scenery can be made both from the sea in boats or from coastal access points. In addition the use of aircraft could provide access to more remote areas, especially to the coast of Devon Island, as well as providing visitors with overall views of the area. If a terrestrial park is established in conjunction with the marine park, coastal view points may be accessible from backshore trails or roads.

### (f) Wildlife Watching

The Lancaster Sound/Eclipse Sound/Bylot Island area contains some of the most diverse wildlife in the eastern Arctic. Opportunities are available to the visitor to view many types of seabirds and marine mammals first hand, and would provide the wildlife photographer or artist with a variety of subjects.

Bird watching would be one of the most readily available activities to visitors. Coastal areas along southern Bylot Island support large colonies of seabirds and these areas are easily accessible from Pond Inlet. The breeding areas of the northwest and southeast corners of the island could be reached by boats during the summer open-water season.

Marine mammals such as whales, seals and polar bears could be viewed from boats or from coastal view points. Aircraft could be used to provide visitor access to wildlife in more remote regions, such as the ice edge in Lancaster Sound.

Orientation of visitors to unique habitats and nesting sites during critical periods would be needed to protect the wildlife. Information on polar bears would be necessary to protect the visitor from potential harm.

### (g) Historical and Archaeological Appreciation

A great deal of the history of the Canadian Arctic is associated in part with the Eclipse Sound/Lancaster Sound area. There is considerable interest among Canadians in the history of the Arctic, as evidenced by the recent attention to the ill-fated Franklin expedition. Visitors to the area could experience first-hand the environment that early European explorers struggled against and study the activities of whalers and traders in the region. Of particular interest would be the old whaling and trading sites along the coasts of Eclipse Sound and Pond Inlet. In addition to this more modern history, visitors could experience a part of Canada that has been populated for thousands of years. Several sites of the early prehistoric cultures (e.g. Dorset and Thule) are located in the study area. There would also be opportunities to visit with the present Inuit of the region, a people who still maintain many of their traditional ways of life.

### 4.2.2 Access and Transportation

Transportation and access within the study area can be analyzed using three principal criteria. These are a) mode of transport b) size of transport and c) seasonality of transport. The mode of transportation can be divided into the three principal categories of air, sea and land. The vehicles which fit into each of these categories can be divided into size groups (e.g. small boats, large boats, cruise ships). Seasonality is an important consideration as much of the area is covered by ice or snow for eight or more months of the year. A listing of transportation as it would relate to the study area is given in Table 4.2 and 4.3.

Aircraft would provide the primary mode of transport to and within the study area. Access to the potential park region is primarily via air transport with minor secondary access via supply ships during the summer months. Within the study area aircraft could provide visitors with a good overview of the park resources in the form of overflights. Viewing of both biological and physical resources could be provided with little to no additional facilities as charter aircraft already operate out of Pond Inlet. Access to remote areas could be provided by float planes or land based planes with tundra wheels during most of the summer months and access via ski-planes could be provided during the winter. Helicopters could operate during most of the year, but would have limited range with fuel available only at Pond Inlet or Nanisivik. Aircraft would be ideally suited to transporting visitors to remote facilities (e.g. fishing camps), from which other means of transport would be used for local travel.

During the summer months watercraft would provide the second major mode of transport. The most common forms of marine transport which would be realistically operated within the region would be small outboard runabouts or kayaks. The Inuit people have used boats in the area for a long time and have always used small, easily manuverable water craft. This type of craft is also easily pulled out of the water at campsites and/or points of interest along the coast. Small water craft will be used mostly by wilderness adventurers and fishermen. For most park visitors, these excursions should be guided for reasons of safety.

**Table 4.2 Transportation Within The Lancaster Sound/Bylot Island/Eclipse Sound Area.**

| MODE | SIZE | WINTER<br>OCTOBER - JUNE | SUMMER<br>JULY - SEPTEMBER |
|---|---|---|---|
| Aircraft | Large | Scheduled Regional Transport | Scheduled Regional Transport |
| | Small | Land planes<br>Ski planes<br>Helicopters | Land planes<br>Float planes<br>Helicopters |
| Watercraft | Large | | Cruise ships |
| | Moderate | | Tour boats<br>overnighters |
| | Small | | |
| | Powered | | Runabouts |
| | Nonpowered | | canoes/kayaks<br>sail boats |
| Land/Ice | Large | Tracked vehicles | Tracked vehicles |
| | Small | Skis<br>Snowmobiles<br>Dogsleds | Hiking<br>All terrain vehicles |

**Table 4.3 Transportation Constraints.**

| TYPES | TIME OF THE YEAR | CONSTRAINTS ON OPERATION |
|---|---|---|
| AIR | | |
| Land planes | June - October | Seasonal, few landing sites |
| Float planes | July - September | Seasonal, only useful in sheltered areas |
| Ski planes | December - June | Seasonal, few landing sites |
| Helicopters | All year | Restricted range; expensive |
| WATER CRAFT | | |
| Cruise ships | June - October | No local port facilities; offship activities would require additional support. |
| Tour boats | July - September | Limited facilities, only day or short trips |
| Runabouts | July - September | Experienced user, limited fuel, harsh conditions |
| Kayak/Canoe | July - September | Experienced user, harsh conditions |
| LAND/ICE | | |
| Tracked vehicles | All year | Limited facilites, rough terrain, fuel |
| Snowmobile | December - June | Experienced user, limited fuel, harsh conditions |
| Dog sled | December - June | Experienced user, food for dogs, harsh conditions |
| Skiing | December - June | Harsh conditions, access |
| ATV | June - October | Experienced user, fuel, rough terrain |
| Hiking | July - September | Access, harsh conditions |

Larger boats could be operated out of Pond Inlet in the form of daily tours around local waters or as longer overnight excursions. This type of transport would provide access to the park for a greater range of individuals as knowledge of wilderness survival would be less necessary. This type of service would, however, require greater support facilities (e.g. haulout facilities) than are now available at Pond Inlet. If the interest was sufficient, however, it could provide a potential business opportunity for the local community, both from tour operation and wage employment from guiding.

The interest in cruises along the inside passage to Alaska along the west coast of Canada has increased dramatically in the last few years. The potential for similar cruises to the study area along the east coast could also be promoted. These cruises would provide visitors with an excellent opportunity of viewing the natural environment and experiencing the routes of early explorers as well as providing safe and comfortable accomodations. This type of operation would bring people into the Canadian Arctic environment who would never otherwise experience it. Cruise operations would have to be self-contained as no support facilities exist in the area for large passenger ships, and none are likely to be built.

Land transportation would provide access along the beaches in the summer and across the ice in the winter. In the summer months, hiking along the shore zone would be possible in areas close to Pond Inlet or on remote coastlines made accessible via boat or air transport. The establishment of a terrestrial park in conjunction with the marine park could provide more beach access via backshore trails or roadways. The use of All Terrain Vehicles (ATV) could provide motorized transport in the summer; however, the coastlines of the study area are generally rugged and steep and this type of transport would be limited. Uncontrolled vehicle transport in the summer months could also be detrimental to coastal habitats (i.e. waterfowl nesting colonies). Large tracked vehicles could operate in the vicinity of Pond Inlet, providing group tours. The expense and limited accessibility of these vehicles to most of the region would limit their use.

During the winter months, and especially in the spring and fall when climatic conditions are not too severe and daylight hours are longer, much of the study area is readily accessible from Pond Inlet across the frozen waters of Eclipse Sound. Cross country skiing along the coastal zones would provide ideal opportunities to view the winter landscape. Access via snowmobile or more traditional dog sleds would provide the user with a unique arctic experience. This type of park use would again be for persons wanting a wilderness adventure experience, not for the average urban tourist. For the general park user large tracked vehicles could provide tours across the ice, but as discussed above this would be an expensive operation and would require increased support facilities.

# 5.0 BOUNDARY SELECTION

The previous report sections provide considerable detail on the natural and cultural resources of the Lancaster/Eclipse Sound marine area, and as such, provide the basis for park boundary delineation. Important concerns addressed in the delineation process are:

- proposed marine park boundaries should maximize representation of natural themes in the Lancaster Sound marine region;
- boundaries should exclude areas whose reduced naturalness cannot easily be reversed, for socio-economic or other reasons;
- boundaries should reflect existing or potential use conflicts;
- boundaries and park area should include consideration of visitor use; and
- boundaries and proposed park area may be used to reinforce sovereignty in the territorial sea.

A summary of these issues is provided in Section 5.1, followed by a consideration of boundary alternatives in Section 5.2 and our recommendation of the best combination of western, eastern and offshore boundary options in Section 5.3.

## 5.1 BOUNDARY AND MARINE PARK CONCERNS

### 5.1.1 Thematic Representation

A principal concern in the park identification process is achieving maximum thematic representation within the proposed boundaries. Natural themes are documented within Section 2 of this report and key elements of the theme representation are summarized below:

## Physical Resources

Some of the outstanding physical features of the region include:

- the high relief coastal area of southern Eclipse Sound;
- the tide-water glaciers and ice sheet of southeastern Devon Island;
- the barrier island/lagoon complex of northeastern Bylot Island:
- the Lancaster Sound ice arch;
- recurring leads along the northern shore of Lancaster Sound;
- the polynya off eastern Bylot Island.

These outstanding features are summarized in Figure 5.1.

## Biological Resources

The Lancaster/Eclipse Sound area is renowned for its biological features, most notably:

- the major concentrations of migratory and nesting marine birds which occur in the area;
- the high concentrations of marine mammals.

Locations of major marine mammal and bird concentrations are shown in Figure 5.2.

## Cultural Resources

The marine resources of the Lancaster/Eclipse Sound area have been utilized by the indigenous peoples for over 35 centuries and non-native peoples for over 100 years. Some important features of the cultural resources include:

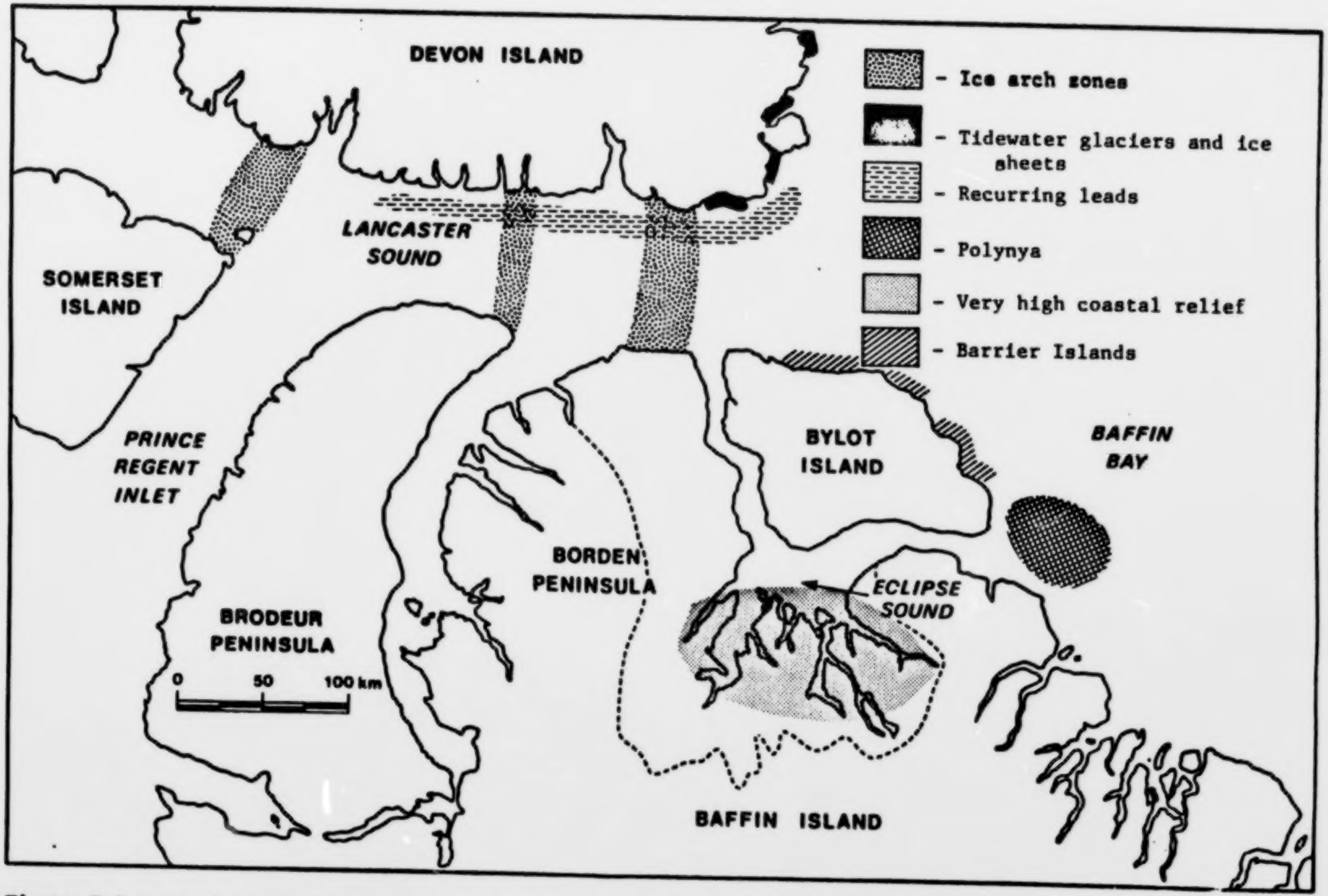

DEVON ISLAND
- Ice arch zones
- Tidewater glaciers and ice sheets
- Recurring leads
- Polynya
- Very high coastal relief
- Barrier Islands
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

Figure 5.1 Key physical features of the Lancaster/Eclipse Sound area.

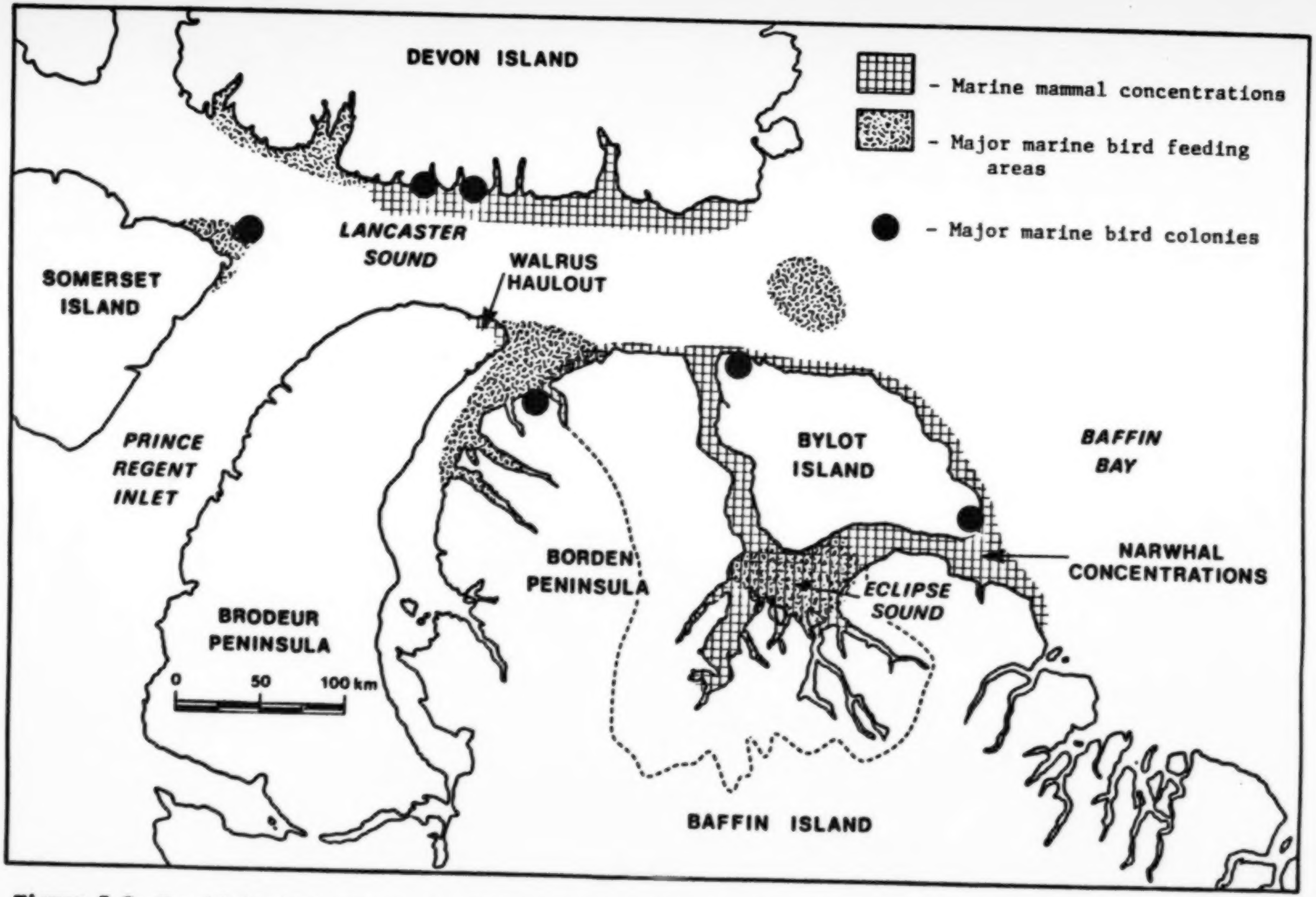

▦ - Marine mammal concentrations
▨ - Major marine bird feeding areas
● - Major marine bird colonies
DEVON ISLAND
LANCASTER SOUND
SOMERSET ISLAND
WALRUS HAULOUT
PRINCE REGENT INLET
BRODEUR PENINSULA
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
NARWHAL CONCENTRATIONS
ECLIPSE SOUND
BAFFIN ISLAND
0
50
100 km

**Figure 5.2** Key biological resources of the Lancaster/Eclipse Sound area.

- the high concentration of archaeological sites along Navy Board Inlet and Eclipse Sound;

- a number of historical sites, including whaling stations, exploration camps and shipwrecks;

- traditional harvesting sites, which often are closely associated with archaelogical sites;

- sport fishing sites, used in the current tourist trade.

The location of these resources has been summarized in Figure 5.3.

### 5.1.2 Naturalness

An important part of the park selection process is to identify areas that would be difficult to restore to their natural condition. Despite the vast area included in the present park study, there are relatively few locations which are not in a natural state. Major exceptations are (a) the community of Pond Inlet, (b) the Arctic Bay/Nanisivik area, and (c) the Milne Inlet terminus of the Mary River mine road. Parks Canada policy ensures that Pond Inlet, Arctic Bay and Nanisivik would not be included within park boundaries. Should the Mary River mine port in Milne Inlet not proceed, cleanup of the road terminus area would be relatively straightforward. Other areas of concern, but to a lesser degree are the former coal mine at Salmon River, the abandoned structures at Dundas Harbour on southeastern Devon Island, and the discarded oil drums found on many beaches in the study area. These sites are indicated in Figure 5.4.

### 5.1.3 Use Conflicts

There are at present no serious use conflicts between the conservation goals of a park and existing human activities in the study area. However, a number of proposed developments are considered in terms of park boundary delineation. Potential use conflicts include:

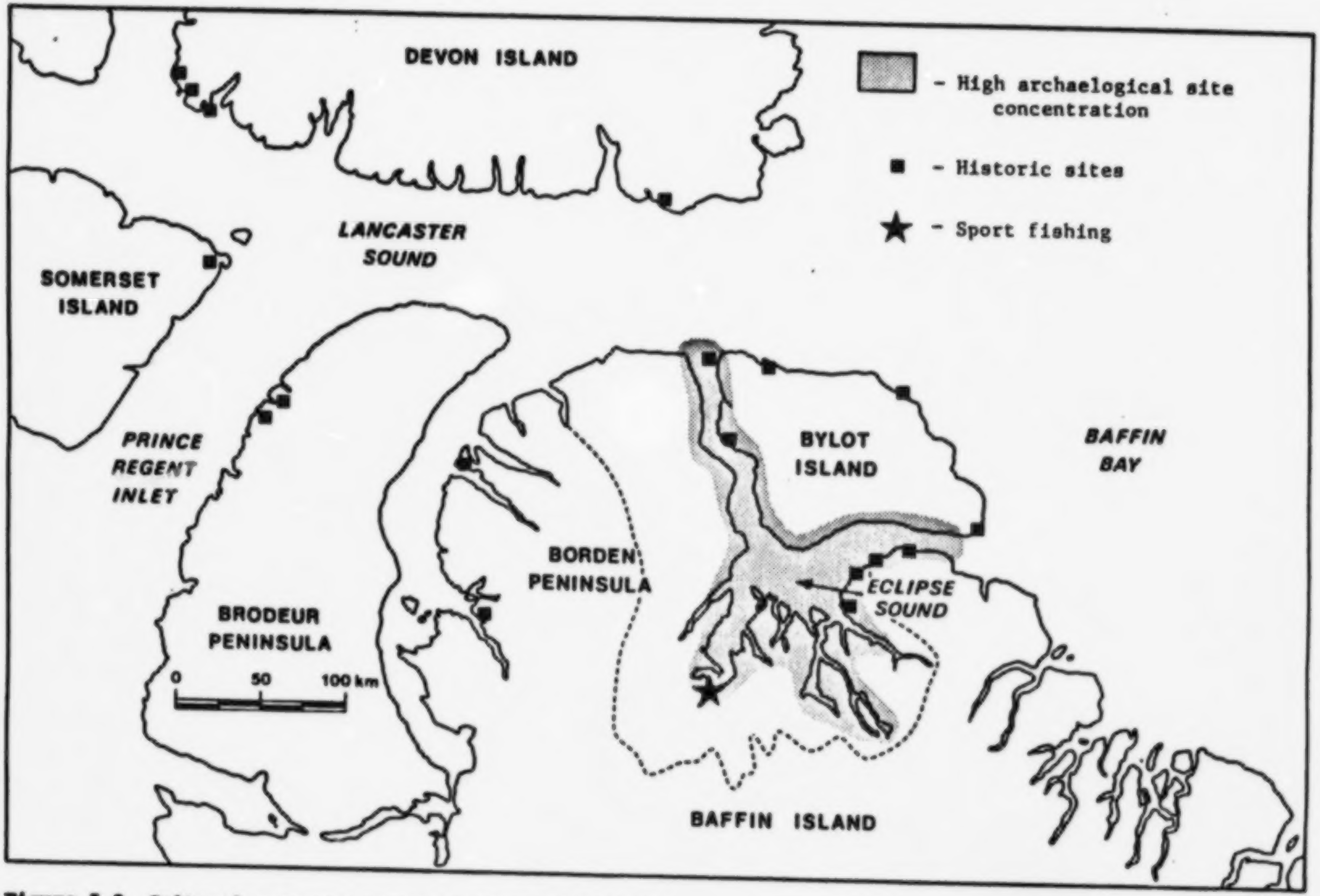

DEVON ISLAND
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BRODEUR PENINSULA
BORDEN PENINSULA
BYLOT ISLAND
ECLIPSE SOUND
BAFFIN BAY
BAFFIN ISLAND
0
50
100 km
▨ - High archaelogical site concentration
■ - Historic sites
★ - Sport fishing

**Figure 5.3** Cultural resource areas or sites of high interest.

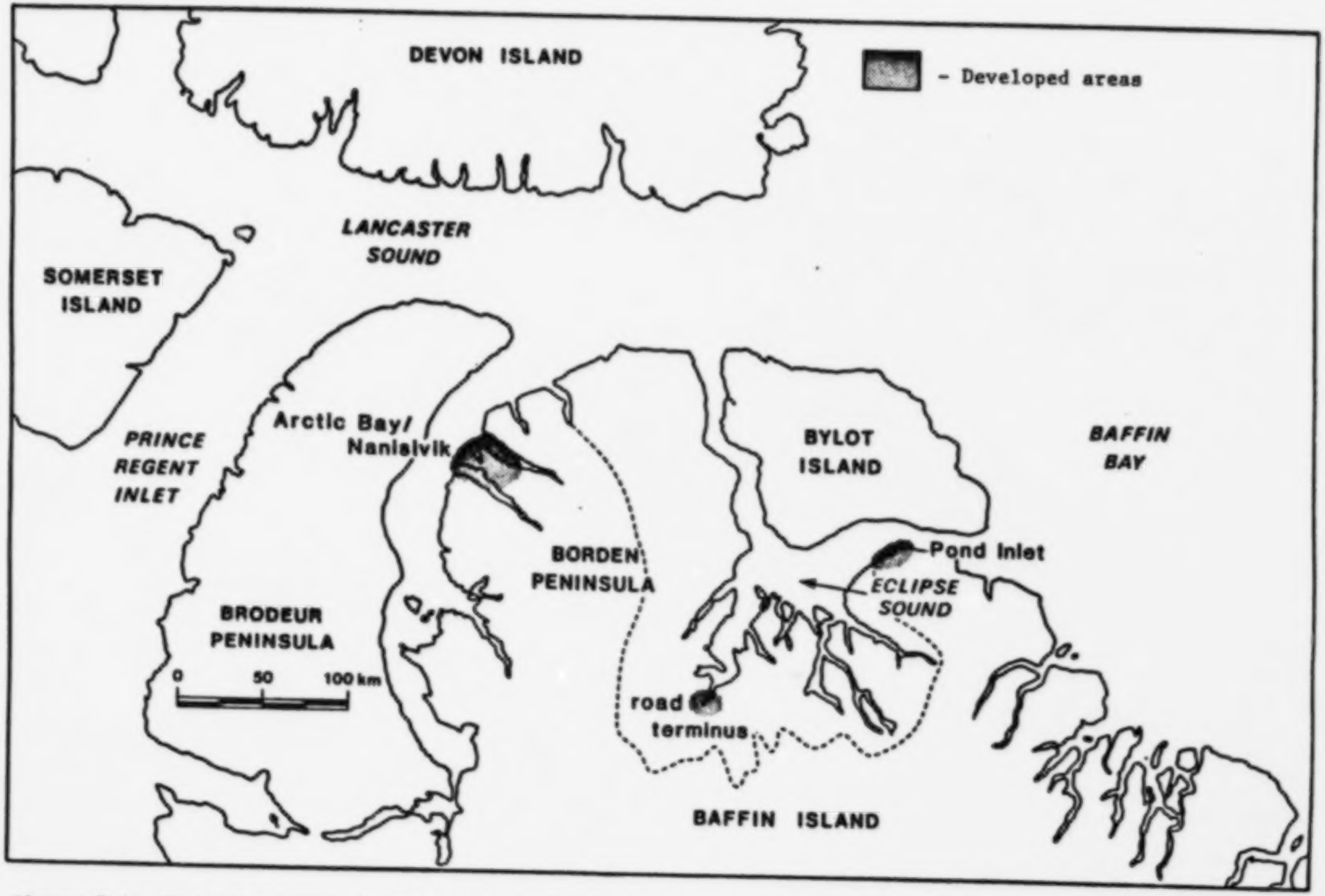

DEVON ISLAND
- Developed areas
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
Arctic Bay/ Nanisivik
BORDEN PENINSULA
BYLOT ISLAND
BAFFIN BAY
Pond Inlet
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
road terminus
BAFFIN ISLAND

Figure 5.4 Developed areas of the Lancaster/Eclipse area, other areas essentially in a completely natural state.

- hydrocarbon exploration, production and support facilities;
- mining activities;
- shipping.

Although oil exploration would pose minimal use conflict with park activities, there is the potential for major oil discoveries, production and associated development required to support production. In the production phase of development, major port and support facilities would be required, such as have been developed at Tuktoyaktuk and McKinley Bay in the Beaufort Sea. In addition, there is the potential for oil spills to occur in both the exploration and production phases. As such, oil exploration and production, particularly if large reserves are discovered, are the most significant concerns in terms of use conflict. Areas of high hydrocarbon potential are indicated in Figure 5.5; they are centred in east-central Lancaster Sound.

Mining activities presently occur west of the study area, on the Borden Peninsula, and additional activities have been proposed. There is some likelihood of future mining or associated port activity closer to Eclipse Sound (on the east side of the Borden Peninsula), and/or in southern Milne Inlet should the Mary River mine be developed. The major impact of mining activities occurs onshore, however, and the principal concerns within a marine park would be (a) shipping of ores from the area, and through the critical southern Milne Inlet area in particular, and (b) tailings discharges into park waters, whether directly or by river discharge. Locations of active, proposed and possible mining activities are shown in Figure 5.5.

Shipping will not be a prohibited activity in marine parks, but it is of direct concern in terms of the possible effects on local biological populations. In particular, year-round shipping of resources from other parts of the arctic through Lancaster Sound has been identified as a serious environmental concern because the shipping could endanger the

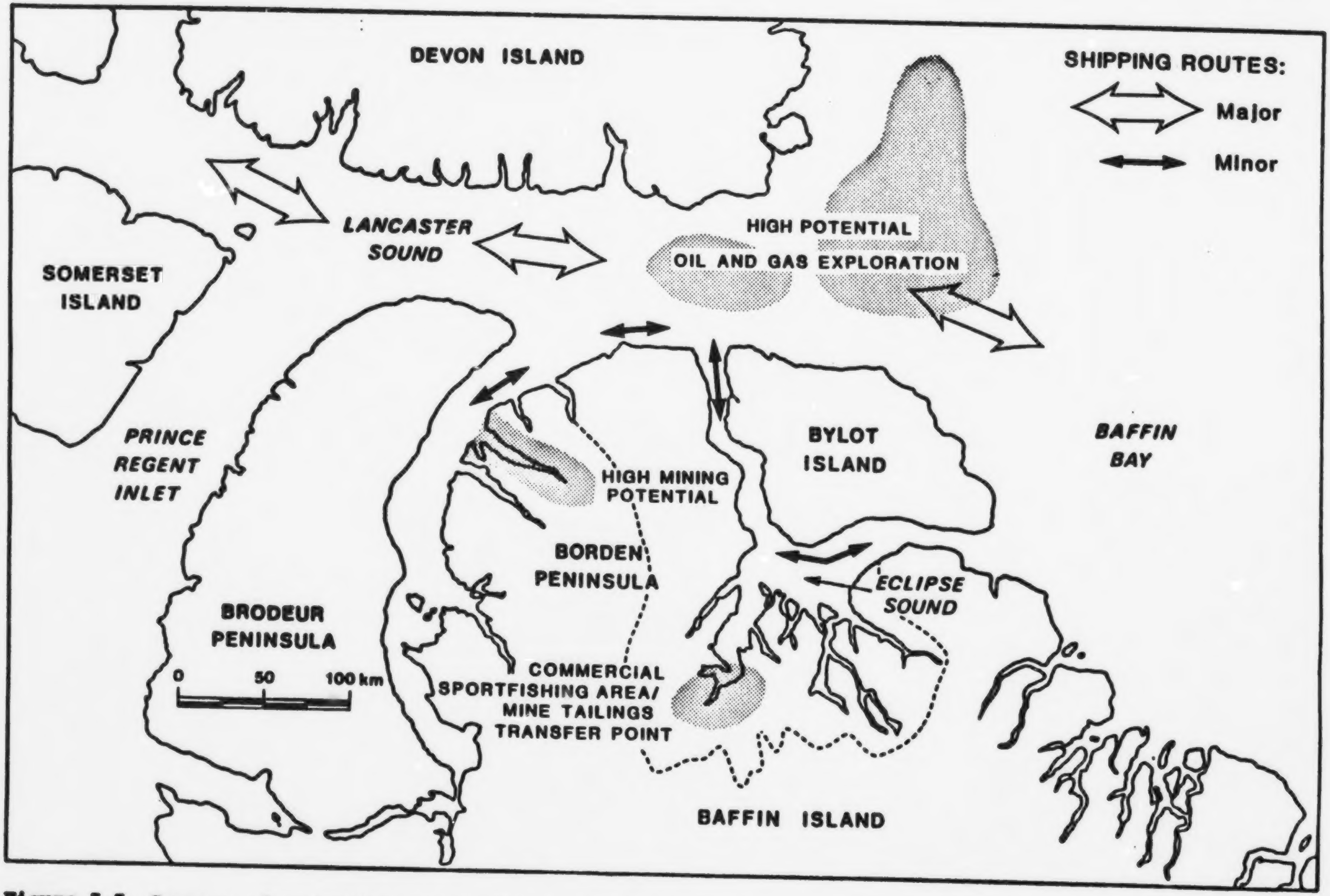

DEVON ISLAND
SHIPPING ROUTES:
Major
Minor
LANCASTER SOUND
HIGH POTENTIAL
OIL AND GAS EXPLORATION
SOMERSET ISLAND
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
HIGH MINING POTENTIAL
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
COMMERCIAL SPORTFISHING AREA/ MINE TAILINGS TRANSFER POINT
BAFFIN ISLAND

Figure 5.5 Summary of potential use conflict activities.

integrity of the Lancaster Sound ice arch. Given the biological importance of this ice arch, the potential effect on park ecology could be far-reaching if the ice arch was altered on a more or less permanent basis. In addition, concerns have been expressed about marine mammals following ship tracks through the ice and becoming trapped in these tracks. Major and minor shipping routes are indicated in Figure 5.5.

### 5.1.4 Visitor Use

There are several natural hazards that would be of concern in planning visitor use to a Lancaster Sound region marine park and may effect boundary delineation. However, because of the probable wilderness nature of the park and the considerable expense of reaching it, most visitors are expected to be relatively well-prepared for hazardous conditions. Reliance on Inuit for guides would further reduce the potential for visitors encountering hazardous situations.

Small boat travel is of significant concern in terms of visitor use because:

- vessels typically used in the area are small to facilitate beaching;
- in the extensive open-water areas of Eclipse Sound, Lancaster Sound and Baffin Bay, storm-generated waves can be large;
- there is limited search and rescue capability in the eastern arctic;
- near-zero water temperatures cause rapid hypothermia and death in the event of accidental immersion.

As a result of these factors, small vessel travel more than a few miles from shore would be a somewhat risky venture for an inexperienced visitor.

Two other hazards in the area are:

- iceberg calving (at glacier front) and iceberg rolling, and
- the high concentration of polar bears on northern Bylot Island.

While both of these hazards occur throughout the marine region, they are most concentrated along southeastern Devon Island and northern Bylot Island, respectively (Figure 5.6). Again, the provision of appropriate visitor information and reliance on experienced Inuit guides would lessen the likelihood of unfortunate accidents.

### 5.1.5 Territorial Sea

In September 1985 the Government of Canada, by Order in Council, proclaimed a territorial sea in the Lancaster Sound region; the baseline defining the territorial sea boundary is indicated in Figure 5.7. The baseline for the 12 nautical mile boundary extends from Cape Cockburn on Philpots Island to the DeRos Island, then to Cape Sherard on Devon Island, south to Cape Hay on Bylot Island, along the coast of Bylot Island to Cape Graham Moore and then to Cape Bowen on Baffin Island.

## 5.2 BOUNDARY OPTIONS

Our assessment of the natural themes of the study area leaves no doubt that Eclipse Sound, some portion of eastern Lancaster Sound, and the connecting waterways (Pond and Navy Board inlets) warrent inclusion within the proposed park area, as suggested by earlier, less-detailed studies. In the subsections which follow, boundary options are advanced which take into account all of the boundary issues reviewed in Section 5.1.

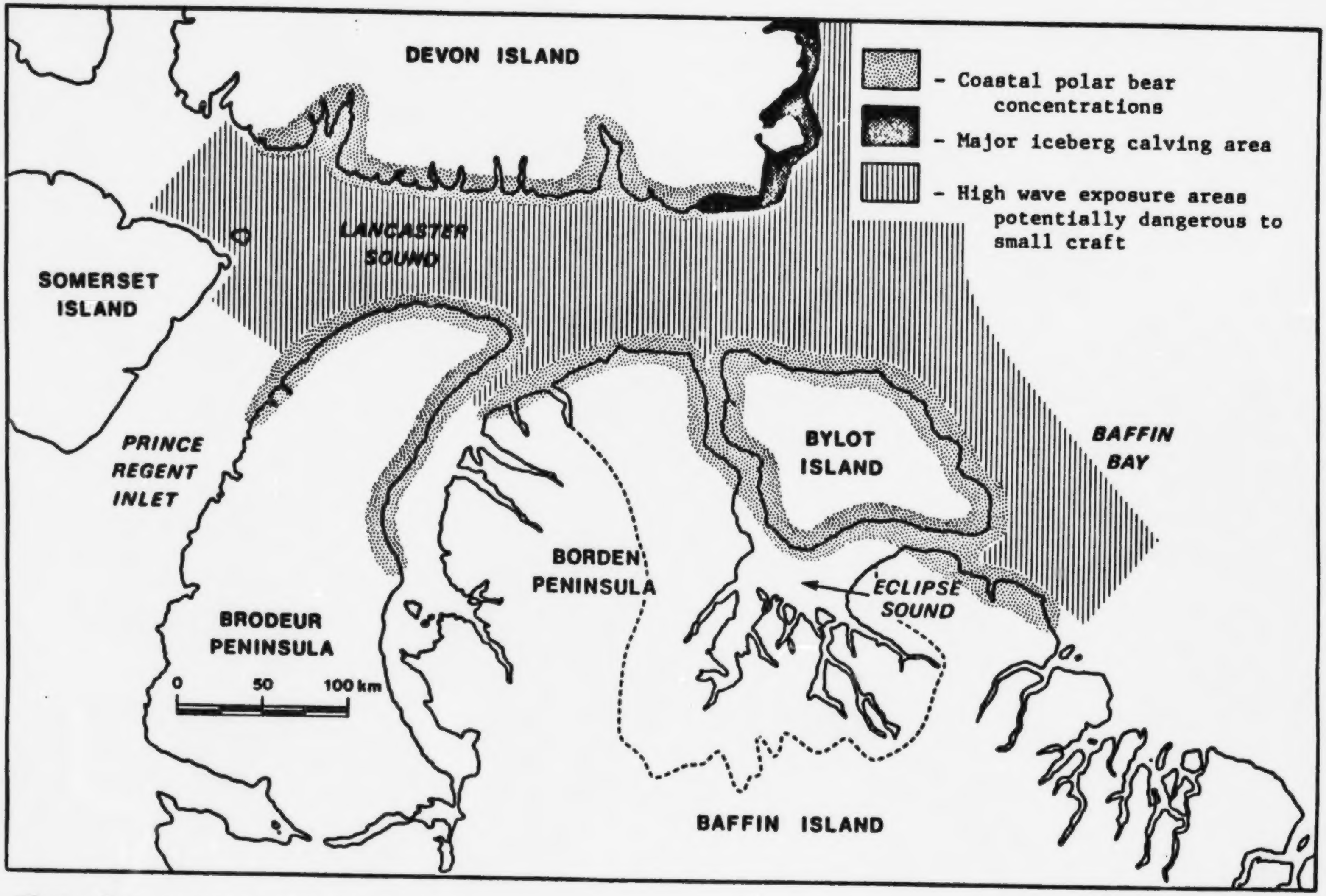

DEVON ISLAND
LANCASTER SOUND
SOMERSET ISLAND
PRINCE REGENT INLET
BRODEUR PENINSULA
BORDEN PENINSULA
BYLOT ISLAND
ECLIPSE SOUND
BAFFIN BAY
BAFFIN ISLAND
0
50
100 km
- Coastal polar bear concentrations
- Major iceberg calving area
- High wave exposure areas potentially dangerous to small craft

**Figure 5.6** Hazards to visitor use.

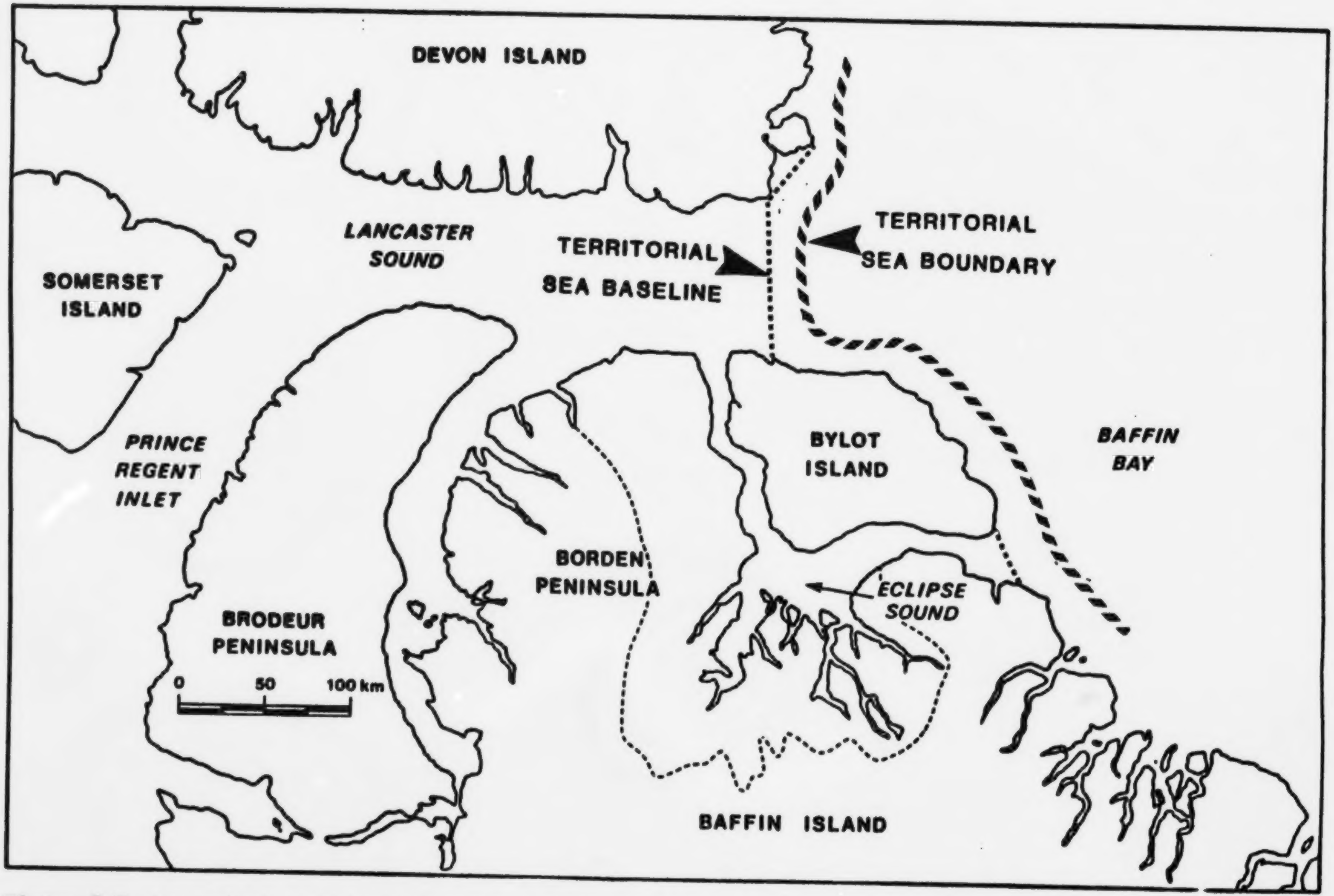

DEVON ISLAND
LANCASTER SOUND
SOMERSET ISLAND
TERRITORIAL SEA BASELINE
TERRITORIAL SEA BOUNDARY
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

**Figure 5.7** Approximate territorial sea boundary as proclaimed by Order of Council (1985).

### 5.2.1 Western Boundary

The location of the previously delineated western boundary of the NACS, as defined by Dobbin 1981a, is indicated in Figure 5.8. The principal factor that should be used in the delineation of this boundary is the Lancaster Sound ice arch. This ice arch is a prominent physical feature of the area and more importantly is known to be an important biological feature, along which concentrations of organisms, including marine mammals, often occur. The significance of this biophysical feature warrants its inclusion within park boundaries.

Unfortunately, the position of the ice front varies significantly from year to year (see Figure 5.8). Based on historical records of the ice front (Marko, 1982), it appears that the ice front occurs approximately 25% of the time within the previously defined NACS (Figure 5.7, Alternative A). The likelihood of occurrence of the ice front within the park could be improved (a) slightly by extending the NACS boundary to the Brodeur Peninsula (Figure 5.8, Alternative B) or (b) significantly (to >75% occurrence) by extending the boundary westward to Somerset Island (and including Prince Leopold Island) (Figure 5.8, Alternative C). This latter change would increase the area of the proposed park by almost 50% and therefore must be considered a radical alternative.

Alternative "B" provides better theme representation than "A" (Figure 5.8) because (a) representation of the ice arch and associated biological features are improved, (b) an important walrus habitat on the northeastern tip of Brodeur Peninsula is included and, (c) important bird colonies (Figure 5.2) at Baillarge Bay and Hobhouse Inlet are included. There is no difference in potential use conflicts between Alternative "A" and "B".

There is no question that representation of the ice arch and associated biological features could be substantially increased by selection of

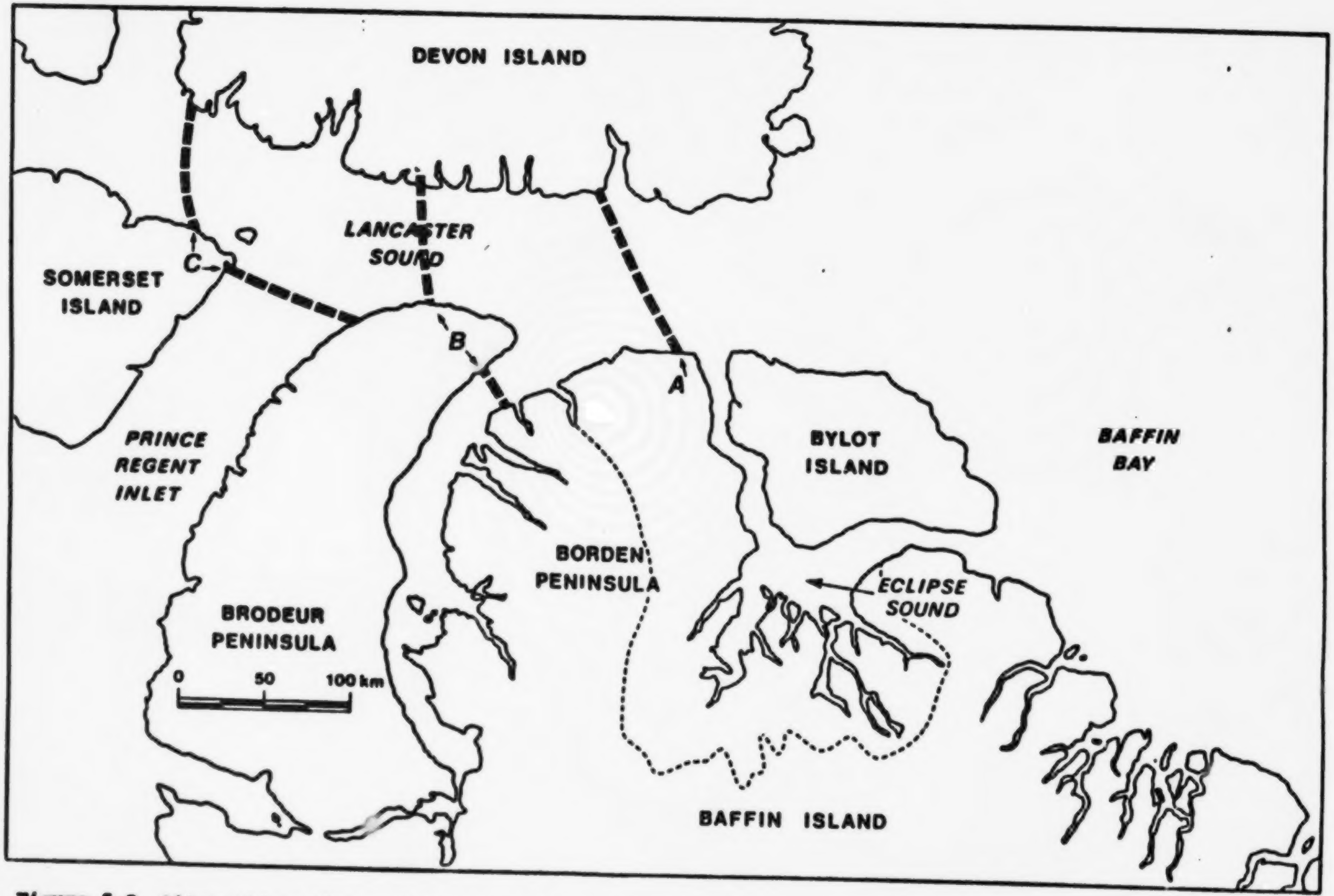

DEVON ISLAND
LANCASTER SOUND
SOMERSET ISLAND
C
B
A
PRINCE REGENT INLET
BYLOT ISLAND
BAFFIN BAY
BORDEN PENINSULA
ECLIPSE SOUND
BRODEUR PENINSULA
0
50
100 km
BAFFIN ISLAND

Figure 5.8 Alternatives for positions of the western boundary; Alternative "A" was that proposed by Dobbin (1981a).

Alternative "C"; annual representation of the ice arch would be achieved 80% of the time with Alternative "C". In addition, major bird colonies at Prince Leopold Island would be included within the marine park. This boundary area is outside of our original terms of reference, and Parks Canada should consider Alternative "C" in more detail in the future.

In summary, a westward extension of the western NACS boundary is recommended. Two alternatives may be considered: one ("B") offers a slight improvement in ice arch representation, and significant improvements in marine mammal and seabird habitat representation; the other ("C") offers a substantial improvement in ice arch representation, seabird representation and historic site representation (e.g. Beechey Island) along the southwest cost of Devon Island. However, this latter alternative results in a nearly 50% increase in the proposed park area and is considered a radical alternative in terms of our original terms of reference for this project.

### 5.2.2 Eastern Boundary

The eastern boundary area is indicated in Figure 5.9, along with the territorial sea baselines established by Order in Council in 1985. Two alternatives are considered. Alternative "D" is essentially that proposed by Dobbin (1981a), with the one major difference of shifting the boundary eastward to improve representation of the offshore polynya that frequently occurs in this area. However, comparison of this boundary option with Figure 5.5 indicates that a potential conflict exists with proposed drilling plans in the Lancaster Sound area. For that reason, Alternative "E" is proposed to minimize use-conflicts. In terms of theme representation, there does not appear to be any significant difference between the two alternatives. Deep water habitats would be less extensive in Alternative "E" but are still considered adequately represented in the area to the northeast of Bylot Island.

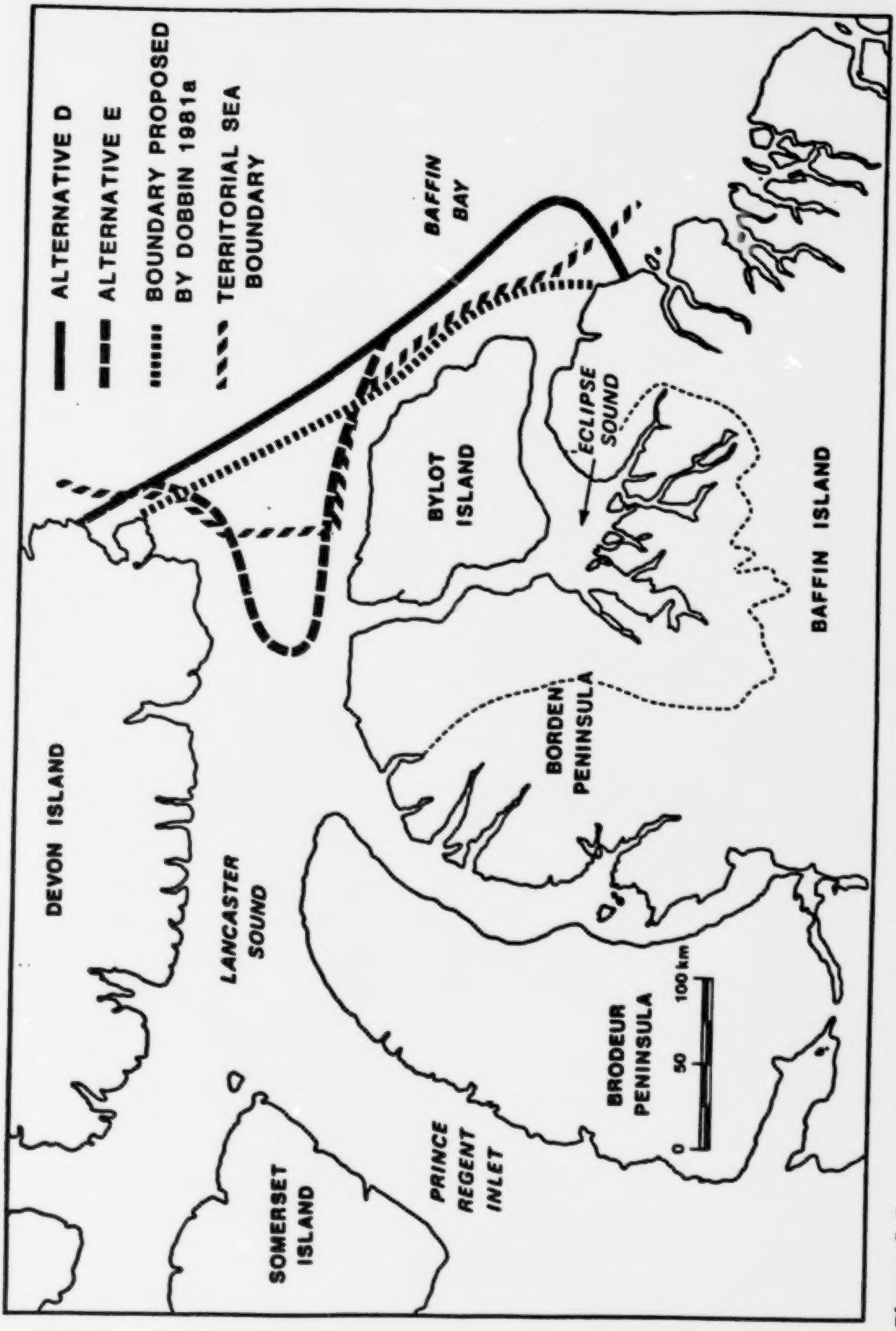

ALTERNATIVE D
ALTERNATIVE E
BOUNDARY PROPOSED BY DOBBIN 1981a
TERRITORIAL SEA BOUNDARY
BAFFIN BAY
DEVON ISLAND
LANCASTER SOUND
BYLOT ISLAND
ECLIPSE SOUND
BAFFIN ISLAND
BORDEN PENINSULA
BRODEUR PENINSULA
PRINCE REGENT INLET
SOMERSET ISLAND
0
50
100 km

Figure 5.9 Two alternatives for the eastern boundary.

Alternative "E" closely corresponds to the territorial sea baselines except at the mouth of Pond Inlet, where it extends beyond the territorial sea to incorporate polynya areas and in central Lancaster Sound, where it lies inside the boundary to minimize potential use conflicts within Lancaster Sound.

### 5.2.3 Offshore Extent of Proposed Park

The coastal zone represents an important element of the proposed marine park in that (a) many of the biological resources are concentrated at or near the coast, (b) coastal landforms themselves represent a unique and highly visible component of the marine system and (c) the coastline will be the principal focus or staging area for most visitor activities within the park. This coastal focus of visitor activities will be accentuated further along Bylot Island and northern Baffin Island shores by establishment of the proposed North Baffin national park on land. Therefore, an a priori assumption is that all segments of the marine park will have a coastal component. Given this assumption, and having considered the eastern and western limits of the park, the important question remaining is: what should the offshore extent of the park be?

After reviewing the distribution of natural resources in the Lancaster Sound NACS, we have concluded that there is no single natural criterion that can be used to delineate the offshore boundary of a park; the boundary cannot be defined on the basis of depth or on the basis of distance from shore alone. For example, marine mammals tend to be concentrated in a fairly narrow band near the coast on the north side of Lancaster Sound whereas in Eclipse Sound, they are comparatively uniformly distributed over the entire Sound. As a result, the seaward extent of the park is delineated on a segment-by-segment basis as follows:

- Eclipse Sound - many of the biological themes and cultural themes are relatively uniform in distribution in the Eclipse Sound area. Because these themes are uniformly distributed and because there appears to be little potential for offshore use conflicts, it is recommended that the park include the entire area of Eclipse Sound. In contrast to much of Lancaster Sound, where most visitor activities would be along the coast, it is anticipated that much of the offshore Eclipse Sound area would be used by visitors transiting to shore points or viewing marine resources. Therefore, no seaward boundary is recommended within Eclipse Sound.

- Northern Lancaster Sound - a boundary lying approximately 20 km to the south of the shore of Devon Island appears appropriate in that (a) there is a high concentration of marine mammal activity within this zone, (b) water depths increase rapidly from the coast so that deep-water physical and biological resources are represented within this zone, and (c) there are no significant natural themes occurring beyond this 20 km limit that do not occur within it. The definition of the limit at 20 km also has the advantage of minimizing potential use conflicts (e.g. the high-potential hydrocarbon development areas that lie within the central portion of the Sound).
- Southern Lancaster Sound - a boundary on the south side of Lancaster Sound is more difficult to delineate because of the relatively poor data bases for this area. However, most natural resources appear to be represented within a comparatively narrow zone adjacent to the coast. No additional themes are added by extending the boundary beyond 20 km.

The latter two discussions argue for a 20 km (12 nautical mile) seaward limit for the park (Alternative "F"). The primary reason to consider this alternative is to minimize use conflict with proposed offshore drilling activities and, to a lesser extent, shipping. Most significant themes would be represented within Alternative "F" boundaries, although the degree of representation is not as great as if no seaward limit were considered. However, only 40 km of ice arch would be represented compared to 80 km if the entire width of Lancaster Sound were included.

Alternative "G" is the no-seaward-limit alternative wherein the proposed park would extend across Lancaster Sound. This alternative would result in better representation of natural themes but with a greater use - conflict potential (oil and gas exploration, shipping).

Alternative "F", if selected, would result in two separate park components: a comparatively small northern Lancaster Sound component, and a larger southern Lancaster Sound and Eclipse Sound component. The deeper water areas of Lancaster Sound would be largely unrepresented except in coastal fringes, but there are few biological or physical themes that would not be represented in the coastal fringe areas (one exception is the migratory habitat of the dovekie which lies approximately 30 - 50 km seaward of the land). There is a precedent for a multi-component park within Parks Canada system at Pacific Rim National Park, which includes three distinct and completely separate components.

In spite of these arguements, Alternative "G" (the no seaward limit in Lancaster Sound) is recommended over Alternative "F" because it preserves the integrity of the Lancaster Sound Ice Arch, a significant biophysical feature of the region.

### 5.2.4 Excluded Areas

Two sites are recommended for exclusion from the proposed park. These are:

- the village of Pond Inlet, and a suitable buffer zone surrounding it,
- a marine terminus site in southern Eclipse Sound for the Mary River mine, should its developement appear probable. In view of the significance of Koluktoo Bay as a subsitence/sport fishing area and as an area of reported high narwhal concentrations, Parks Canada may wish to divert potential port development from the Milne Inlet area.

Parks Canada should also recognize the potential need for shore support facilities, should offshore oil exploration in Lancaster Sound be permitted at some time in the future; both Dundas Harbour and Crocker Bay on Devon Island have been considered in past development concepts. Prior to finalizing boundaries, Parks Canada should designate one or two coastal sites for support base development. By designating such sites in advance, it should be possible to minimize later support base impacts (e.g., ship traffic and air traffic) on an established park.

## 5.3 PREFERRED ALTERNATIVES

The preferred alternatives for park boundaries are shown in Figure 5.10, along with other alternatives. The recommended park boundaries are:

- Alternative "B" for the western boundary,
- Alternative "E" for the eastern boundary, and
- Alternative "G" for the central Lancaster Sound area, between the Borden Peninsula and Devon Island.

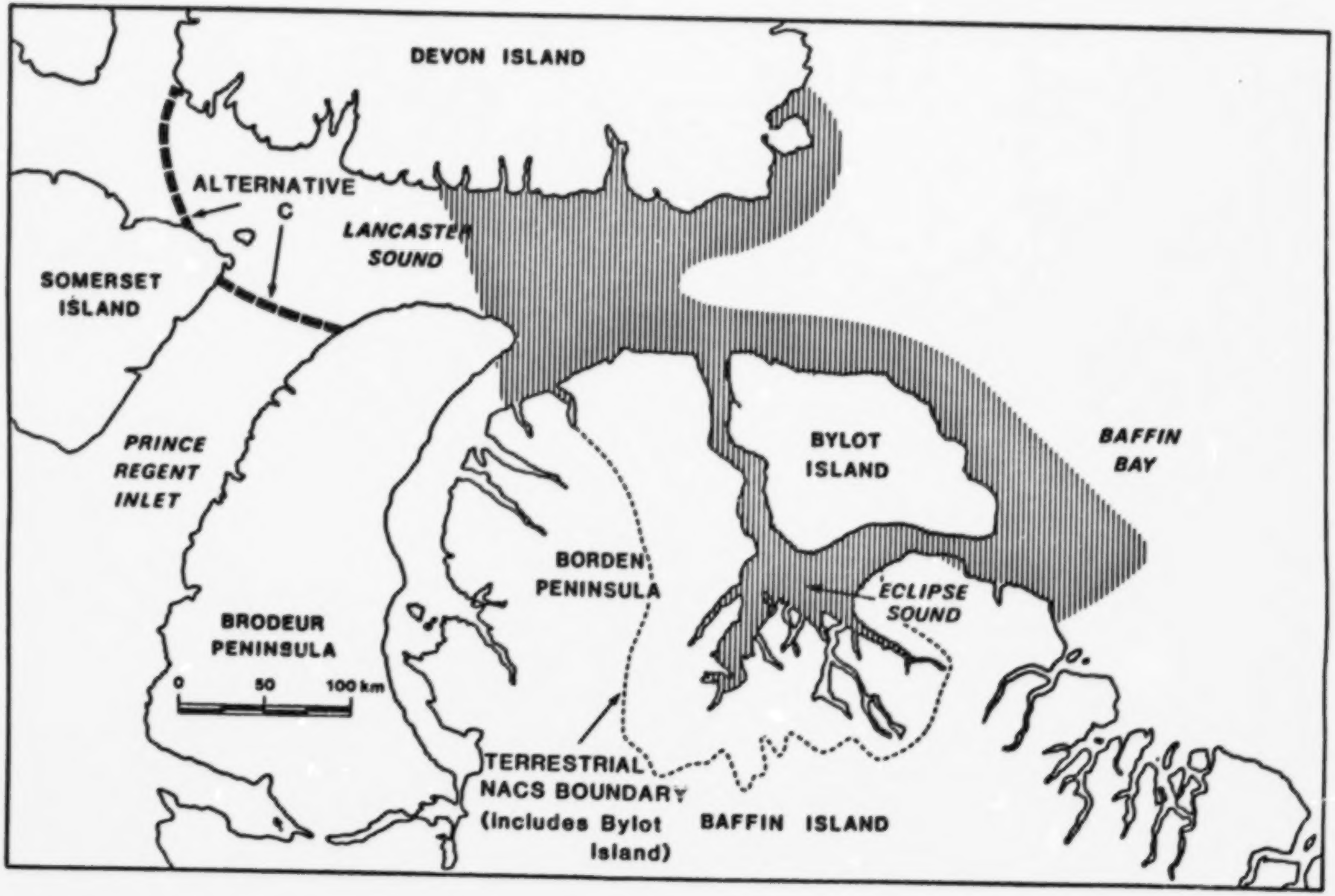

DEVON ISLAND
ALTERNATIVE
C
LANCASTER
SOUND
SOMERSET
ISLAND
PRINCE
REGENT
INLET
BORDEN
PENINSULA
BYLOT
ISLAND
BAFFIN
BAY
ECLIPSE
SOUND
BRODEUR
PENINSULA
0
50
100 km
TERRESTRIAL
NACS BOUNDARY
(Includes Bylot
Island)
BAFFIN ISLAND

**Figure 5.10** Preferred boundaries of Lancaster/Eclipse Sound marine park. Note good overlap with terrestrial NACS boundaries. Selection of Alternative "C" would substantially improve representation of natural themes, but require significant increase of park area.

Alternative "B" is indicated as the preferred western boundary option not because it provides the best representation but because it conforms most closely with the original terms of reference. Alternative "C" provides for a substantially better representation of one of the major biophysical features of Lancaster Sound, the ice arch, but requires increasing the proposed park area by as much as 50%. As a result of the substantial increase in area, this alternative should be carefully evaluated by Parks Canada.

To the east, Alternative "E" is preferred over Alternative "D" because it offers the potential to minimize potential use conflicts without substantially affecting theme representation. In addition, the area of difference is considered of lower visitor use potential because of its exposure and distance from shore (Figure 5.6).

With regard to across-Lancaster-extent of a park, Alternative "G" is preferred over Alternative "F" because of the improved representativity of natural themes. However, the potential for use conflict with oil exploration is minimized by retention of Alternative "E", in the eastern park of the park area.

Note that the proposed eastern boundary of the proposed park corresponds reasonably closely to the 12 nautical mile territorial sea limit in most areas, and as such enhances Canada's sovereignty claims; in the central Lancaster Sound area, the proposed park boundary lies inside the 12 mile limit to minimize conflict with potential oil development and in the area east of Pond Inlet, the proposed boundary lies substantially outside the 12 mile limit to include important polynya areas within the proposed park.

The proposed marine park boundaries provide complete overlap with the proposed terrestial park.

# 6.0 REPRESENTATIVITY OF PROPOSED PARK

A comparatively large portion of the Lancaster/Eclipse Sound Marine Region is represented within the preferred park boundaries (estimated at 10% of the total region area) and to our knowledge, no significant natural themes or theme categories have been omitted.

## 6.1 PHYSICAL REPRESENTATION

All major physical theme categories are represented within the preferred park boundaries and, in a few cases, unique theme categories are also included. All major coastal environments are adequately represented, including fjord coasts, tide-water glacier coasts, raised beach ridge plain coasts and barrier island coasts; the latter exist along the north shore of Bylot Island and are unique to this marine region.

Oceanographic themes are adequately represented within the proposed park boundaries. These include the polynya areas of Lancaster Sound and eastern Pond Inlet, fjord-circulation phenomena, and the oceanographic dynamics of Lancaster Sound. The somewhat unique ice front or ice arch that forms across Lancaster Sound and that has important biological consequences is represented within the preferred park boundaries approximately 25% of the time.

Major physiographic phenomena are also well represented within the proposed park boundaries. The areas along the north and south shores of Lancaster Sound and western Lancaster Sound contain water depths in excess of 1000 m so that deeper water phenomena such as iceberg scouring and offshore benthos are likely to be adequately characterized.

## 6.2 BIOLOGICAL REPRESENTATION

All major biological theme categories (marine birds, marine mammals, fish, and invertebrates) are well represented within the preferred park boundaries.

### 6.2.1 Marine Birds

The waters of Lancaster Sound and nearby inlets are important staging, routing and feeding areas for many of the seabird species present in the eastern arctic. Large colonies exist on the northwest (Cape Hay) and southeast corners (Cape Graham Moore) of Bylot Island and along the south coast of Devon Island. The waters within a 25 km radius of these colonies are the main feeding areas for nesting birds, while coastal waters along Bylot Island (northeast shores plus Eclipse Sound/Navy Board Inlet) are important during migration, rearing of young and molting. The following outlines the species and areas included within the preferred boundaries:

(1) Seabird nesting colonies (C. Hay, C. Graham Moore) and associated adjacent waters
  - Thick-billed murres (greater than 1,000,000 adults use waters of Lancaster Sound)
  - Black-legged kittiwakes (50 percent of eastern Canadian population)
  - Black guillemots
  - Glaucous gulls

(2) North and east coast of Bylot Island
  - Eider and oldsquaw molting and fall staging area
  - Migration routes for fulmars (45 percent of breeding fulmars in Canada
  - Migration/fall staging area for glaucous gulls
  - Migration route of arctic terns

(3) South and east coasts of Bylot Island and waters of Pond Inlet/ Eclipse Sound/Navy Board Inlet
  - Important nesting site for snow geese, nesting, feeding area for red-throated loon, red phalaropes, king eider, oldsquaw, jaegers
  - Waters are important staging and molting areas for snow geese, eiders, oldsquaws, glaucous gulls

(4) South coast of Devon Island
- Important nesting and staging area for brant (Philpots Island)
- Important fulmar colony (Hobhouse Inlet) and migration route
- Important nesting/rearing staging area for eiders and oldsquaw.

A major seabird colony is located at Prince Leopold Island and adjacent Cape Clarence (I.B.P. Site 1-5; Nettleship and Smith, 1975), west of the preferred park boundaries; this colony can be included if Parks Canada accepts boundary Alternative "C" over Alternative "B".

### 6.2.2 Marine Mammals

Most of the mammals which inhabit eastern high arctic waters use Lancaster Sound as a migration corridor. Some are seasonal residents while a few are present year-round. Their presence is, in part, a function of the high primary and secondary productivity of these waters. Three general areas are described below (all included within the proposed park boundaries):

(1) North and east coast Bylot Island
- Denning areas for polar bears
- Migration route for harp seals, bearded seals
- Offshore areas include large numbers of ringed seals
- Possible walrus haul-out areas and summer feeding (Wollaston Islands)
- Narwhal migration route (along with S. Devon Island, 80 percent of North American population)
- Beluga whale migration route (along with S. Devon Island, 40 percent of world population)
- Bowhead and Killer whale migration route

(2) Navy Board Inlet/Eclipse Sound/Pond Inlet
- Summer areas for polar bears
- Narwhal nursery/rearing area (Koluktoo Bay)
- Ring seal rearing
- Historical nursery for bowhead whale
- Beluga whale summer resident

(3) South coast of Devon Island
- Major beluga whale and narwhal migration route
- Bowhead whale migration route
- Main migration route for walrus, and some summer haul-out areas
- Harp and bearded seal migration route
- Important wintering area for polar bears.

### 6.2.3 Fish

There are insufficient data to document regional distribution of most fish species or their relative abundance and importance. There does not, however, appear to be any unique or regionally important species in the study area. The coastal waters of Eclipse Sound and Navy Board Inlet are locally important for arctic char and several large (greater than 100,000 adults) spawning streams discharge into this area. There are no known suitable spawning areas in Lancaster Sound itself. Polar cod, an essential food item for many arctic species, is locally abundant and widespread in its arctic distribution.

### 6.2.4 Plants and Invertebrates

The data base for these groups is poor. Benthic production may be higher in Lancaster Sound compared to other arctic areas. Abundance is greatest at intermediate depths (5-50 meters) and those invertebrate species present appear to be an important link in the primary production - marine fish - sea birds/marine mammals food web. Both invertebrate and plant species assemblages present are similar to others found in northern temperate and arctic waters. For invertebrates, geographic position, depth and sediment composition are the main factors in determining the makeup of the community. Depth and substrate (primarily hard bottom) are factors in the distribution of marine plants.

### 6.2.5 Primary Production

Compared to most arctic waters, Lancaster Sound is considered to have higher than average phytoplankton and zooplankton populations which, in part, are responsible for the abundance of marine mammal and sea bird species and numbers. The area along the north shore of Bylot Island, extending out to the center of Lancaster Sound, is the region of higher concentrations, especially at the entrance to Baffin Bay. Another region of higher production exists southeast of Philpots Island (eastern Devon Island). No unique or regionally important species have been identified.

## 6.3 CULTURAL REPRESENTATION

Cultural themes are well represented within the proposed boundaries. Major concentrations of archaelogical sites on the shores of Eclipse Sound are included as are most major historic sites within the region (Figure 5.3). Because of the nearly complete coverage of important sites, an important consideration for Parks Canada will be a management strategy that assures preservation of these sites.

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